Clemson University
3 1604 019 420 563

Digitized by the Internet Archive
in 2013

http://archive.org/details/firecontrolnotes79fore

Volume 7 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Address Division of Fire Control
Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1946

Contents

Page

We resume 1
Division of Fire Control, U. S. Forest Service
Note to contributors 2
A. A. Brown
Unit protection by air control 3
Northern Region, U. S. Forest Service
Special fire swatter 5
Charles R. Gerard
Adapting Army equipment to forest-fire fighting 6
Major C. A. Rowland, Jr.
Smoke masks and goggles 15
Oley Scott
Helicopter hopes for fire control 16
David P. Godwin
Portable water heater 22
Curtis E. Price
DDT—fire-fighters' friend? 23
H. T. Gisborne
Gravely fire-line broom 24
Albert Howard
Training in fire-fighting tactics 26
Glen R. Durrell
Rotary fire mop 30
Philip H. Murphy
Postwar truck 31
Fighting fires with jeeps 32
Perle Lewis
Revised fire-control equipment handbook 33
Simplifying fire-fighters' mess 34
H. M. White
The sandbox as a fire-control training tool 37
D. H. Euler
E. D. reports 39
Night attachment for forest fire-finders 40
William Heckman
Science tracks down woods burners 41
Henry Sipe
Florida camp trailer 45
Southern Region, U. S. Forest Service

WE RESUME

Division of Fire Control, Washington Office, U. S. Forest Service

After nearly 4 years of wartime suspension, FIRE CONTROL NOTES gets back into circulation and will be published quarterly, fulfilling its mission, we hope, even more successfully than before.

About a year ago a special effort was made to resume publication, but the wartime limitations then placed upon the form and content of the periodical would have so changed its character that we decided to wait until better times. Under those limitations, we would have been required to confine the contents to the single subject of fire-control equipment.

Now with a clear green light, we can move ahead with a periodical substantially the same as prewar issues and cover the entire field of fire control with the breadth of expression and subject matter set forth in the text of the flyleaf immediately preceding this article. That statement will, as in the past, express our editorial policy. FIRE CONTROL NOTES will be distributed to a mailing list of about 4,000.

The contents of this first postwar issue have not the diversity we or the readers desire. The articles run heavily to equipment, since for some time it was thought that we would be confined to that category of subject matter. What we lack and badly need are expressions of thought in the whole broad field of fire control—new views on our big, pressing problems and their solution. If articles are provocative and controversial, so much the better. The value of this periodical will be determined by what you and other readers contribute. Something in your fire-control thinking and work is interesting and helpful to others. Write it up and give other men some return for what they have given you.

We have room for long and short articles. Those familiar with the prewar issues will recall the interesting "shorts" which were interspersed throughout the pages. These were brief, compact notes—100 to 200 words—on new and interesting items. They brought sharp focus to limited, though often important, aspects of the fire-control job. We would like more of them.

In setting up FIRE CONTROL NOTES again we have followed closely the original format, arrangement of articles, and character of lay-out, but undoubtedly many readers will have good ideas for improvement and pepping up the style and appearance. We welcome criticisms and constructive suggestions. Special features or departments somewhat in the Reader's Digest style might add interest and liveliness. Perhaps we could run a column on "what's going on" which would carry brief news items on special activities, proposals for new experiments, unusual equipment developments, or even ventures in the realm of "imagineering." It might afford an outlet for what may seem to be wild ideas. A scheme or gadget is seldom practical in its original form, but presenting it in print enables others to help get rid of the kinks and perfect it.

And a final word to contributors. We want your articles and contributions badly, but we make a special plea that you read and follow the instructions on the inside of the back cover as to form and illustrations and save us some headaches. Putting out this magazine is an extracurricular job with us here, and we have neither the help nor time to rewrite, retype, or redraw.

If you really want FIRE CONTROL NOTES, give us all the support possible and we will turn out a creditable periodical which fully serves its purpose.

Note to Contributors.—Many contributors or would-be contributors on fire-control subjects may be a little puzzled as to whether to send a prepared or prospective paper to FIRE CONTROL NOTES or the *Journal of Forestry.* Both are now available to them. At the time of the Equipment Committee meeting in Washington, January 1945, a joint arrangement was worked out for insuring suitable outlets for all fire-control subject matter. At that time the proposed Fire Equipment Notes had to be restricted to fire equipment items. Under that limitation it was agreed that there would be a free interchange of papers submitted between the editor of FIRE CONTROL NOTES and the staff of the *Journal.*

The plan was that the broader subjects would be referred to the *Journal,* with perhaps a "brief" covering their content, particularly as it affected fire equipment, to be printed in FIRE CONTROL NOTES. It was suggested, too, that both publications carry cross references on important developments in the field of fire control described in either. The removal of wartime limitations on subject matter for FIRE CONTROL NOTES now changes this situation, and the question of deciding where a contribution should appear will need to be reviewed again with the pending successor to Editor Samuel T. Dana of the *Journal of Forestry.* However, the writer himself can usually decide pretty well if he will keep his audience in mind. The two audiences differ somewhat.

Readers of the *Journal* are interested in forest fire control in its broader aspects, and in new ideas, methods, and equipment which have wide application. However, they are not interested in many of the mechanical details of how things are made or done. The readers of FIRE CONTROL NOTES, on the other hand, are assumed to have a specialist's interest in fire-control techniques and are a better audience for subjects in these categories. A large proportion are field men particularly interested in things they can put to use in their everyday jobs. The publication serves that need. But the editor of FIRE CONTROL NOTES is also very much interested in publishing material on the philosophy of fire control and many broader subjects. The editor of the *Journal of Forestry* is also interested in these subjects and in getting better coverage of administrative and so-called "nontechnical" fire-control material that represents progress and new thinking. In such fields many contributions will be appropriate to either publication.

For the most part, the choice will be left to the writer, but there is no objection to referring any paper to either editor with the request that it be used where it seems most appropriate. In general, a new idea or gadget that has not yet been fully tried out may be reported in FIRE CONTROL NOTES but is usually not regarded as eligible for the *Journal* until some definite conclusions can be drawn as to its field of usefulness. When that stage has been reached, it may be eligible for either, depending on the author's choice with the different audiences in mind. In many cases it will be worth while for articles to appear in both.—A. A. BROWN, *Associate Editor, Journal of Forestry.*

UNIT PROTECTION BY AIR CONTROL

Northern Region, U. S. Forest Service

Smoke jumping was started in northern Washington in 1939. Early in 1940 the new project was moved to Montana and during the succeeding six seasons the activity progressed steadily through the difficult experimental stages into a practical, full-blown operation which now serves parts of Regions 1, 4, 5, and 6. Now comes a new phase of aerial control. The air personnel and facilities are beginning to take over the tasks of patrol and detection in addition to those of suppression. That this has been done effectively and economically for a selected forest area is evident from this interesting account of an important pioneering effort.

A thorough test of airplane detection of fires combined with smoke-jumping patrol has proven successful on some of the most inaccessible areas of the national forests in Region 1.

In former years, control of fires by the use of smoke jumpers has proven economical, but airplane detection was not entirely feasible. This made it necessary to retain a lookout system in every area, even though better and faster suppression could be obtained with smoke jumpers. Thus a duplication or overlap of coverage was required.

The Continental Unit

The region in which air patrol was tried is known as the Continental Unit, embracing 2,054,000 acres of remote and inaccessible forest land in the Lewis and Clark, Lolo, Helena, and Flathead National Forests. Elevation ranges from 4,000 to 9,000 feet along the Continental Divide which runs north and south through the middle of the region. Inaccessibility and the heavy manning required to give adequate ground-crew protection, along with low man-caused fire occurrence, made it an ideal unit for development of fire control by aerial methods.

Forty-three lookout-firemen positions were discontinued on the Continental Unit, and the money was set aside for flying patrol, training smoke jumpers, etc. The objective was to determine whether better protection could be obtained with the same or less expenditure. Nine lookout-firemen positions were retained to give detection coverage to some of the areas of highest fire occurrence, report the occurrence and path of lightning storms, and furnish data from which the Weather Bureau made special daily forecasts.

In the 1945 season, there were 29 fires on the Continental Unit: 18 were class A, 8 class B, and 1 each classes D, C, and E. All but 5 were attacked from the air, and in addition smoke jumpers suppressed one 120-acre fire by ground attack.

Lightning caused 27 of the fires, a camper 1, and the other, a class E fire which burned 2,270 acres on the extreme boundary of the unit, was started by an automobile exhaust during a high wind. Altogether, 2,413 acres were burned, or 0.11 percent of the area in the Continental Unit.

Faster Attack

It is interesting to note that of the 29 fires, 14 were discovered by aerial observers, 7 by lookouts, and 8 by others. Of the fires controlled with less than 10 acres burned, 4 were potentially dangerous. One fire—on which discovery, report, and first action took only 47 minutes by air control—had an average perimeter increase of 4.4 chains per hour in low-low fuels. This fire would have taken ground forces, by conservative estimate, at least 6 hours for the first attack. The wind was 15 miles per hour and the burning index 71 at the nearest lookout.

Another fire on the same day was controlled at 0.2 acres. Action by air took only 30 minutes after the report was made. At least 6 hours would have been required by ground forces.

Airplane delivering smoke jumper by parachute to spot near forest fire.

Two other fires, with a burning index of 100 at nearby stations, were controlled on this day with total burned acreage of 0.05 acres. These would have necessitated at least 5 hours' travel by ground crews, but air attack averaged 2 hours and 30 minutes. And this was longer than the average because only 2 planes were used to handle 6 fires.

Better Protection—Less Cost

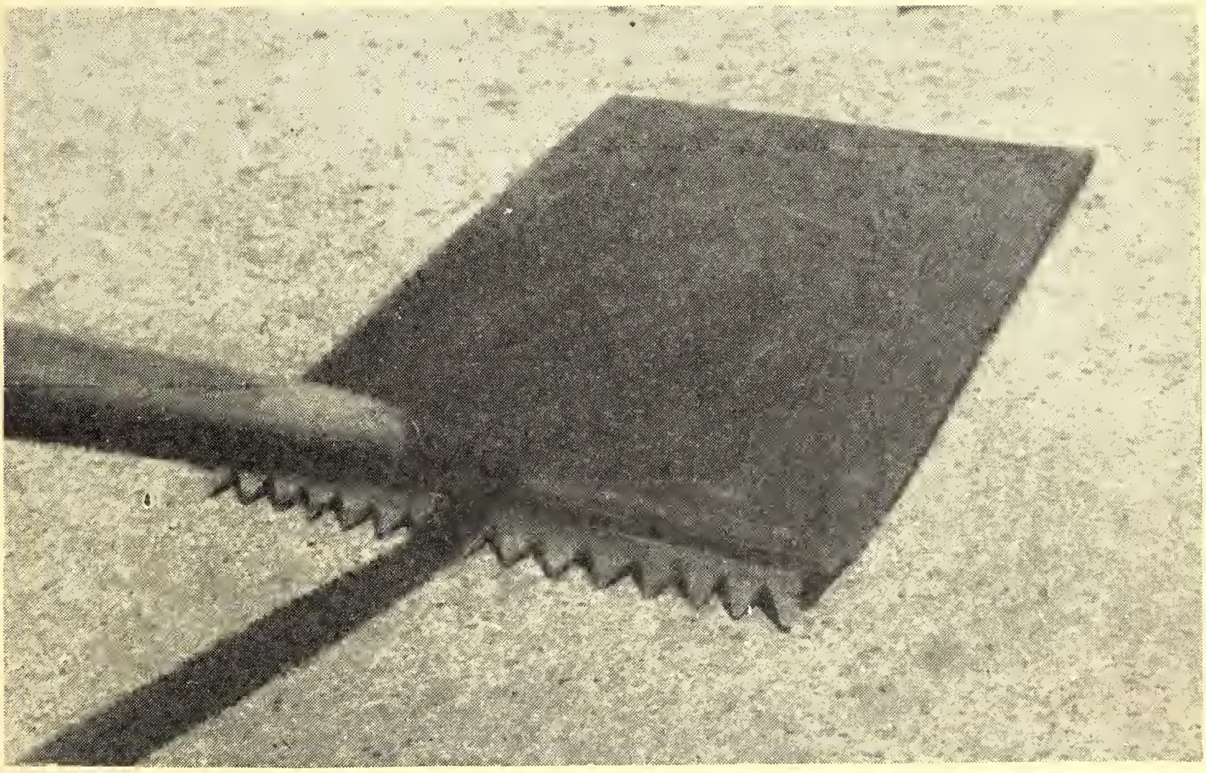
To finance this experiment, allotments ordinarily made to the forests for wages were spent as follows:

Overhead expenses	$6, 240
Patrol flying	7, 442
Smoke jumpers	4, 320
Equipment and supplies	1, 434
Subsistence	1, 107
Operation of motor equipment	315
Travel expenses	165
Total	21, 023

It was demonstrated quite definitely that better protection in such areas as the Continental Unit can be obtained by substituting aerial control for lookout-firemen. At first glance it would appear that no money was saved, but this is far from true. Elimination of 43 lookouts makes it unnecessary to maintain lookout structures and telephone lines and trails to these points. Many other trails and improvements used for fire control alone can possibly be abandoned. There are also other savings, such as reduction in pack stock requirements, overhead for training guards, etc.

It is likely that another unit will be set up in the back country of the Bitterroot, Nezperce, Lolo, and Clearwater Forests.

Special Fire Swatter.—The Blackfeet Indian Reservation fire employees consider the fire swatter their standard tool for control of grass fires. They have found that on many occasions, in order to make the fire line safe, a rake or similar tool was needed to scarify isolated tufts of grass, dung piles, small areas of duff, etc., which were holding fire. Finding it impractical for one fireman to carry both a swatter and rake, a combination tool was made by replacing the rivet bar on the standard swatter with a scarifier made of ⅛- by 1-inch angle iron. Details are shown in the accompanying illustration. To use the scarifier, the handle of the swatter is held slightly lower than the position in which it is held when using the flail.—CHARLES R. GERARD, *Forest Guard, Blackfeet Indian Agency, Mont.*



The Gerard fire swatter, showing detail of toothed rivet bar used as a scarifier.

ADAPTING ARMY EQUIPMENT TO FOREST-FIRE FIGHTING[1]

MAJOR C. A. ROWLAND, JR.

Air Corps, Chief Forestry Section, Eglin Field, Fla.

Major Rowland, a forest officer in Region 8, was commissioned at the beginning of the war and placed in charge of the protection of the large area included in the A. A. F. proving ground in Florida. Due to almost continual aerial practice, testing and incendiary bombardment, the area was a hot one and its protection became a difficult job. In this work Major Rowland was able to secure most of the mechanized units he thought suitable. His adaptations of military equipment to fire-control uses were made with a good sense of design, appreciation of balance and loading limitations, and the best of mechanical workmanship. His experience will be a sound guide when military automotive equipment is finally made available as surplus property.

In June 1940 the Choctawhatchee National Forest in northwestern Florida was transferred to the War Department and became the Army Air Forces proving ground, with headquarters at Eglin Field. This area, of some half million acres of extremely sandy soil, is principally forested with longleaf pine with a scrub-oak understory. The area is characterized by flat ridges which break abruptly to the streams, the majority of which are fed from subterranean sources. On either side of the streams there are comparatively narrow swamps with areas of "flats" adjacent to the larger swamps which are marshy, with a ground cover of wire grass.

Prior to its transfer to the War Department, the United States Forest Service had administered this area since 1909. As fire protection had been practiced for many years, the ground cover and litter became extremely rough and susceptible to fire. The scrub oak, prevalent in the understory, had increased both in size and density because of the fire protection.

Forest fires in this area are almost entirely surface fires, but because of the heavy "rough" and wire grass, there is a rapid rate of spread. It was learned by the Forest Service, that direct attack with water was the best method of stopping the spread of fires here. Fire-fighting technique naturally developed around water-carrying trucks, followed by men to patrol and mop up the numerous snags and debris.

Army Equipment Used

When the War Department took over the area, the fire-detection system was retained and six ½-ton two-wheel-drive pick-up trucks were procured on which were amounted 120-gallon water tanks and Panama fan-belt-driven pumps with the necessary hose and hand tools. These were well-designed units, but with the increase in military operations and the corresponding increase in use of the sand roads and fire lines by heavy trucks, it became impossible to furnish adequate fire protection to the area with these trucks. The fire occurrence was increased by bombing and gunnery missions, despite precautions taken in clearing the ranges and burning off safety zones around them. It became evident that trucks capable of carrying more water, which could traverse the extremely sandy roads and operate on marshy lands, were needed. The fire trucks of the Corps of Engineers were designed for combating structure fires, and the crash trucks were specially designed to fight chemical fires, and regulations prohibited their use for forest fires. The "brush trucks," designed by the Corps of Engineers, were inadequate for conditions encountered, as they had only 2-wheel drive with exposed pumps and fittings which made them impractical for cross-country use. The pumps furnished more water than was ordinarily needed for local conditions, where a small stream of water, which will last for a long period, is of prime importance.

---

[1] Reprinted in slightly condensed form from *Mechanical Engineering*, July 1945.

In 1941, several available types of standard Ordnance vehicles were test-driven in an effort to determine the best all-round vehicle to convert to a fire-fighting truck to meet the needs of this reservation. It was found that the 1½-ton, 4 x 4 Chevrolet cargo truck with 7.50–20 tires was the best available vehicle at that time for a heavy-duty forest-fire truck. For a light patrol truck to replace the ½-ton two-wheel-drive trucks originally procured, the Ordnance ½-ton, 4 x 4 Dodge with metal cab was selected. The Panama pumps in use had given satisfactory service, furnishing sufficient discharge and pressure, so these were used chiefly. The first truck converted was a 1½-ton Chevrolet 4 x 4 cargo truck. Seat frames, tarpaulin, and bows were removed and tanks, with a capacity of 500 gallons, and a new Panama pump were mounted on the truck. This unit proved superior to the lighter two-wheel-drive pick-up both in its ability to reach inaccessible places and to carry sufficient water to combat large fires.

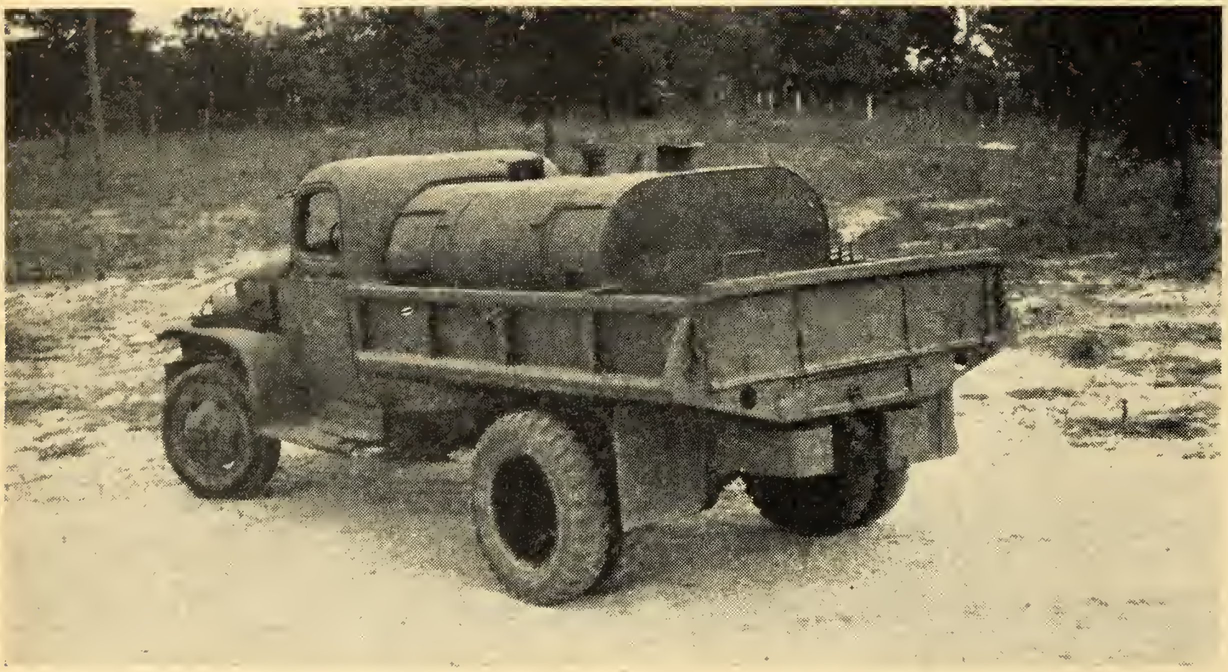
The advantages of the Army-type vehicles with their rugged construction and four-wheel drive were obvious, so all the fire-fighting equipment was converted to four-wheel drive, and experiments were made with as many types of vehicles and pumps as could be secured, to determine the most effective combination of chassis, pump, water tank, and nozzles. The original ½-ton pick-ups were replaced by 4 x 4 Ordnance ½-ton pick-ups with 7.50–16 tires, to which the equipment from the two-wheel-drive trucks was transferred. The following report covers the equipment tested.

Chevrolet 1½-Ton Cargo Truck

The first vehicle to be adapted was an Ordnance 1½-ton, 4 x 4 (2–DT) Chevrolet cargo truck with steel cab and body. Tanks having a capacity of 500 gallons were mounted, and a Panama fan-belt-driven water pump with compensating bypass was installed. This vehicle is well adapted for use as a heavy fire truck in making the main direct attack on forest fires encountered in this locality, with the exception of those on wire grass flats. Its power, maneuverability, and water capacity make it the most satisfactory all-round heavy-duty fire truck tested. It is capable of traveling over rough roads and cross country with a full load, except in flats where the muck is so soft that it will not support the weight.

A similar installation on an identical chassis was made, using a Yale-Towne fuel-transfer pump, operated by a power take-off. This unit gave substantially the same operating efficiency as the preceding unit, the essential difference being the pump. Since the Yale-Towne pump was designed for large volume discharge at low pressure, it refills the tank from natural sources more rapidly than the Panama pump, as two discharge hoses are used simultaneously.

One of the trucks converted was equipped with a winch mounted in front of the radiator, operated by a power take-off. This has proved very effective in enabling the truck to pull itself or other trucks out of sand or mud.

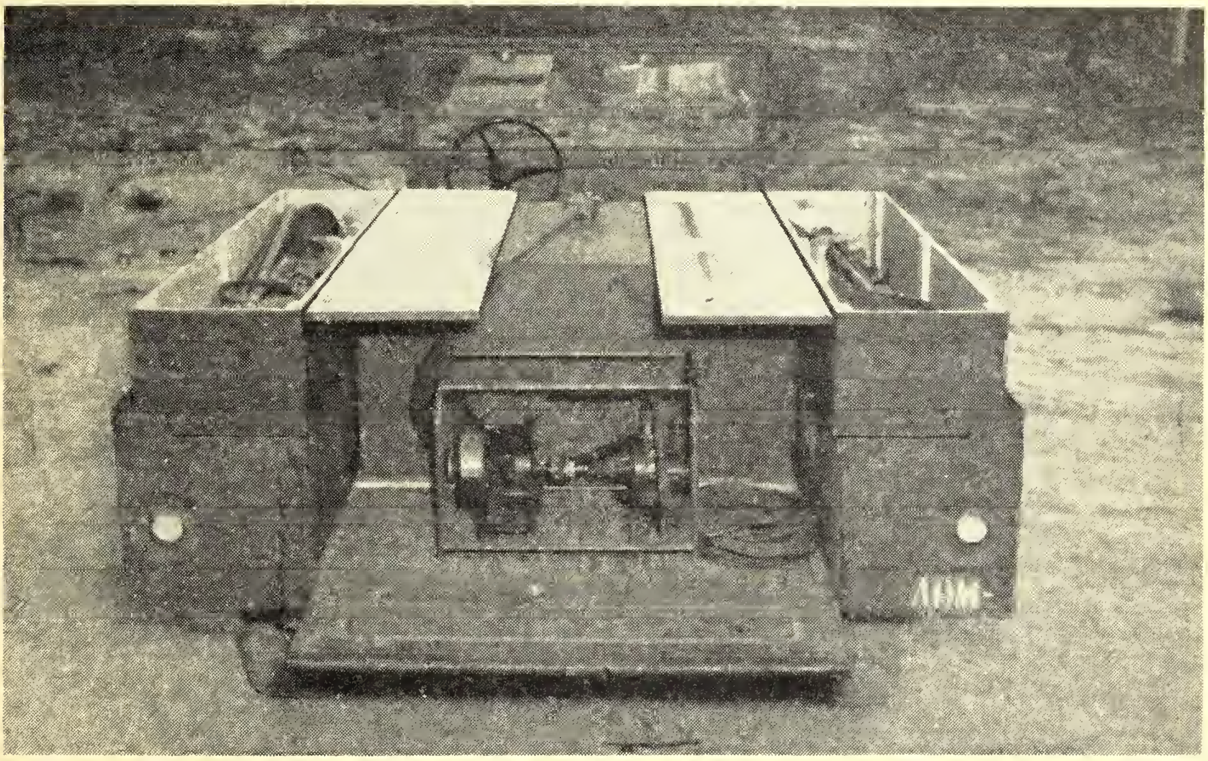


Chevrolet 1½-ton cargo truck showing 500-gallon tank and discharge hose from Panama pump on left front fender. Short hose reduces pressure loss and is adequate for ordinary use; 50 feet of extra hose is carried in truck.

Three-Quarter-Ton Dodge Weapon Carrier

An Ordnance ¾-ton Dodge weapon carrier was converted to a forest-fire-fighting truck by removing tarpaulin, bows, and seat frame and installing a 200-gallon water tank and a Panama fan-belt-driven pump. A metal cab was installed, made of welded tubular steel covered with galvanized sheet iron. Difficulty was experienced in mounting the Panama pump because of the location of the top water-hose connection and generator. This was overcome by making an offset adapter for the base of the pump by bolting two pieces of 2-inch angle iron together, one of which was drilled for the cylinder-head bolts and the other was drilled to match the holes in the base of the pump. This set the pump out 2 inches from the cylinder-head bolts and down 2 inches below the level of the top of the cylinder head and gave adequate clearance between the pump pulley and the radiator hose.

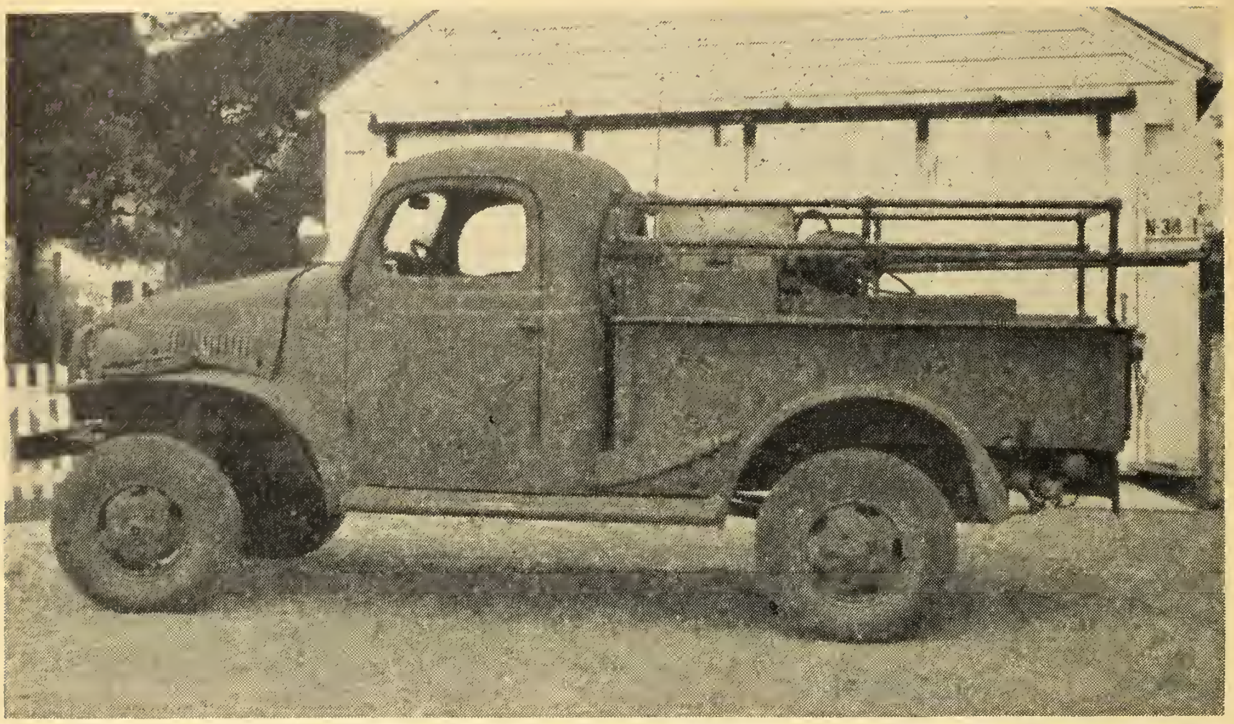
This vehicle handles better than the ½-ton pick-up and its very short wheel base makes it highly maneuverable in the woods. It has ample power, and its large tires (9.00–16) and four-wheel drive give it better traction and more road clearance than the ½-ton pick-up. It is able to travel in more swampy conditions than can either the ½-ton or 1½-ton trucks. While the ¾-ton truck has been used in primary attack, it has less water capacity than the 1½-ton truck and is better suited as a secondary truck, following one of larger capacity. When the fire weather is not extremely bad, this truck can replace a 1½-ton truck. It is the best all-purpose "light" truck tested. Tests demonstrated that 200 gallons is the largest volume of water that can be mounted on this type vehicle without excessive overloading. With this volume, two extra spring leaves had to be inserted in each of the rear springs. The improvised cab without glass makes it less desirable for the driver because of exposure to heat and smoke, but being open allows the hose man to operate the hose from the seat. It is not well adapted to the installation of radio because it does not sufficiently protect the equipment from weather.



Dodge ¾-ton weapon carrier. View taken before installation of cab and Panama pump. Tool boxes replaced seat frames. The pumping unit is a type A–6 fuel-transfer unit, used as an auxiliary fire pump.

One-Half-Ton Dodge Pick-Up

The standard Ordnance ½-ton, 4 x 4 Dodge pick-up with metal cab made a desirable substitute for the original ½-ton pick-ups. Tarpaulin, bows, and seat frames were removed from the truck and the equipment was transferred from the two-wheel-drive pick-up with only minor modifications. It performed as well as the original ½-ton pick-up truck, and the larger tires (7.50–16) and four-wheel drive enabled it to operate on terrain on which the 4 x 2 truck could not travel. The rugged construction reduced the damage to the vehicle when traveling through heavy brush to a minimum. This truck handled its load so well that larger tanks were installed with satisfactory results. Although the original tanks had a capacity of only 120 gallons, 175- and 200-gallon tanks were tested. The rated capac-



Dodge ½-ton pick-up truck equipped with 120-gallon tank, radio installation, hand tools, and discharge hose mounted on left front fender.

ity of the vehicle was exceeded, but it was found that good performance could be obtained when a 175-gallon tank made of ³⁄₃₂-inch sheet iron was installed. The 200-gallon tanks made of heavier material were found to be impractical.

This vehicle is primarily used for forest patrolling and as a secondary truck. Its effectiveness as a patrol truck is greatly increased by installation of a two-way FM radio to keep the dispatcher informed as to the progress of fires and in reporting unusual conditions encountered.

The small water supply limits its effectiveness in furnishing the main direct attack on large fires without support. Its best use in fire fighting has been that of a secondary unit to follow the larger trucks to prevent break-overs or handle small fires which blaze up after the larger trucks have passed. Using the pick-up as a secondary truck reduced the number of men required for patrolling and mopping up fires.

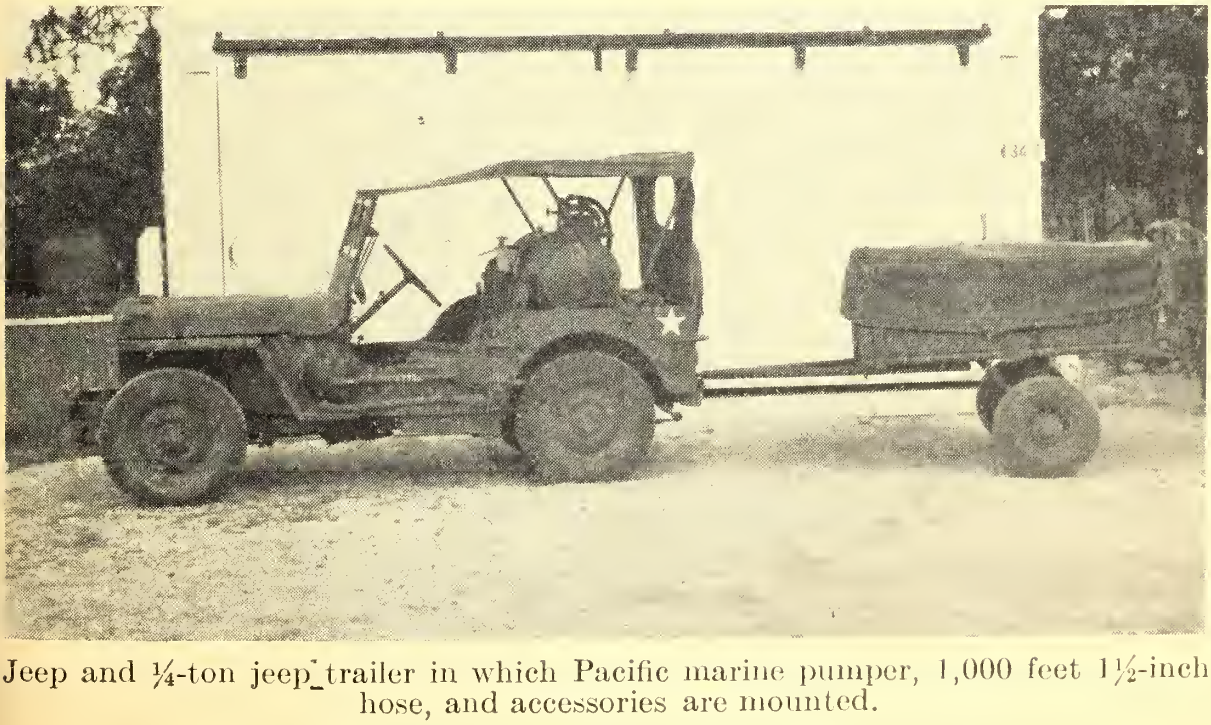
This truck does not have quite the maneuverability or speed of the two-wheel-drive pick-up. As it gets older the steering becomes stiffer and there is more front-wheel vibration, causing greater wear on the front tires. Operating these vehicles on sand roads necessitates frequent replacement of universal joints, particularly on the front drive shafts. The hydraulic-brake tubes are exposed and are frequently damaged in cross-country operation. The truck makes a satisfactory all-round patrol truck, but is underpowered for the job it is performing. The ¾-ton weapon carrier would be a much more satisfactory patrol truck if it had an enclosed cab.

Since the tank capacity is limited, experiments were made with smaller nozzle openings to conserve water. With the 0.25-inch tip, the 120-gallon tanks lasted only 7 to 10 minutes, which is not sufficient time to corral even small fires. It was found that good streams of water were furnished with a properly designed tip having an opening of only 0.14 inch. With this tip, the water supply lasted more than twice as long and was practically as effective in stopping fires, since increased pressure, created by the reduction of the size of the tip, caused the water to be broken down into finer droplets, approaching fog, which gives more efficient utilization. The small tips so increased the effectiveness of the water supply on the pick-up trucks that they were equipped only with that size tip. The same conservation of water was applied to the larger trucks by equipping each with two tips, the 0.14-inch tip being used on all fires except at the heads of large fires and during conditions which made small tips inadequate.

Quarter-Ton Reconnaissance (Jeep)

The vehicle tested was a standard ¼-ton, 4 x 4 Willys reconnaissance (jeep), equipped with 6.00–16 tires. In converting the jeep to a light fire-fighting and patrol vehicle, a 40-gallon pressure tank, salvaged from a soda-acid fire extinguisher, was mounted horizontally immediately behind the front seats. This location was selected so that the weight would be as far forward as possible to distribute the load. On this tank, a tire-tube valve was installed so that air pressure could be applied to force the water out. In addition, a 15-pound carbon-dioxide (CO_2) cylinder was installed so that the pressure could be maintained as the water was forced out. A valve is located to control the flow of water to a 50-foot ¾-inch hose. The nozzle was reduced to ⅟₁₆-inch opening. A pressure gage and pressure-relief valve were installed for safety. The tank can be refilled through the refill opening or by use of vacuum. A vaccum line was run to the intake manifold of the engine, using ¼-inch gasoline-type fittings with ¼-inch copper tubing. A control valve was mounted on the tank and the bleeder valve installed to trap moisture which can be drawn off as necessary. When the vacuum refiller is used, the discharge hose becomes the suction hose.

Thirty-five gallons of water are ordinarily used, allowing approximately a 5-gallon capacity for head space. Pressure on the tank



Jeep and ¼-ton jeep trailer in which Pacific marine pumper, 1,000 feet 1½-inch hose, and accessories are mounted.

is ordinarily kept at 75 pounds, being put in by any air hose or hand pump. As this will not discharge all of the water, the pressure is maintained by periodically opening the valve slightly on the CO_2 cylinder until the operating pressure of approximately 40 pounds is reached. The use of compressed air to build up the original pressure reduces the amount of carbon dioxide needed. Fifteen pounds of carbon dioxide will discharge the tank 5 times. With a nozzle having a 1/16-inch opening at an average of 40-pound pressure, the water supply will last 40 minutes and produce a thin stream which can be sprayed 35 feet. By using the motor vacuum and the hose without a nozzle, the water can be replaced in the tank by vacuum in approximately 4 minutes under normal conditions.

The jeep has been used for all types of patrol activities and is especially good at reaching normally inaccessible places on the reservation. Its most spectacular use has been as a reconnaissance car for a fire "boss" on large fires from which he can watch the operations and make necessary reconnaissance to determine the action to be taken. With its water tank, it is especially useful in this capacity as it can be used to put out any break-overs that may be encountered by the fire "boss" while on reconnaissance. It is very effective in combating lightning fires as it can reach almost any place, and the amount of water carried is sufficient to handle small fires under normal conditions. It can operate on softer ground than any other vehicle tested. The jeep can pull the 1-ton cargo (tool) trailer or the 1-ton 250-gallon water trailer, but these are ordinarily pulled by ½-ton or larger trucks. It is the ideal vehicle for pulling the jeep trailer carrying the Pacific Marine Pumper. The only difficulty encountered in operating the jeep in thick scrub-oak woods is the damage to the top. However, rips which usually occur near the bows can be easily repaired by a shop equipped to handle canvas.

Trailers

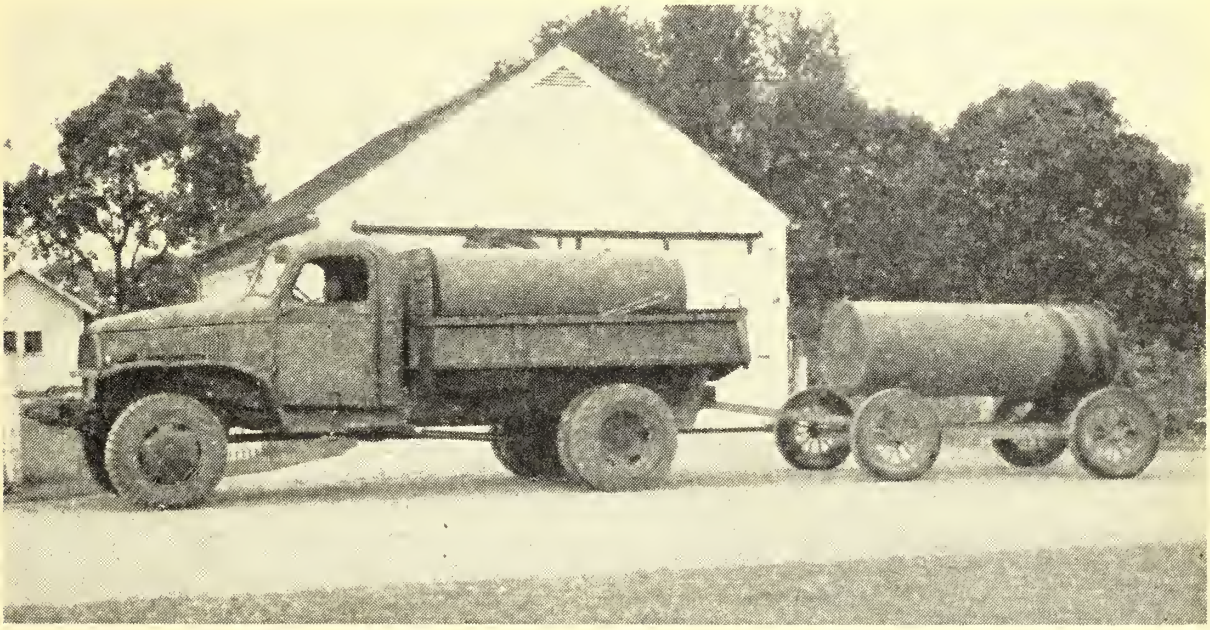
The large acreage of land under protection made it desirable to motorize all fire-fighting equipment possible. In order to make fire tools and special equipment readily available for dispatch, use was made of Army-type trailers. All of the trucks are equipped with trailer hitches, so towing presented no problem.

The Nash-Kelvinator 1-ton, two-wheel cargo trailer made an excellent portable fire-tool box. Three of these units were equipped and located at strategic places for most efficient use. Each was equipped with a complete assortment of hand tools for 50 men. All tools have distinctive markings so they can be replaced on the proper vehicle after use. These kits have saved much lost time in handling tools, and immediately after fires they are made ready for future use. The tarpaulin and tool boxes on the trailers protect them from damage or weather. The 50-man kit consists of the following tools:

10 rakes, asphalt.
10 hoes, council.
15 shovels.
2 saws, cross-cut.
4 axes.
4 pumps, back pack.
4 lanterns, kerosene.
1 burner (back-fire torch).
1 pair snaking tongs.

The 1-ton, 250-gallon Lavine two-wheel water trailer has been used without change as an auxiliary water supply to refill fire trucks and furnish drinking water to fire-fighting crews. In cases where fire fighting was on open land, or where buildings or targets were protected, these trailers have carried an auxiliary water supply directly to the fire behind pick-ups and, when the tank supply of the pick-up was exhausted, the water was pumped from the trailer directly onto the fire by use of a long suction hose from the pump to the trailer.

The 750-gallon four-wheel trailer tank is used as an auxiliary water supply on large fires and to furnish water for the Pacific Marine Pumper when it is operated away from a natural water supply. Use has been made in refilling fire trucks at fires, where the water is pumped from the trailer into the truck by a No. 325 engineer brush truck, the Pacific Marine Pumper, or type A–6 fuel-transfer unit. This trailer has been used, towed by a 1½-ton cargo truck, in protection of buildings or targets, by installing the Pacific Marine Pumper in the bed of a 1½-ton cargo truck and pumping water from the trailer.



The 750-gallon four-wheel trailer tank drawn by 1½-ton truck.

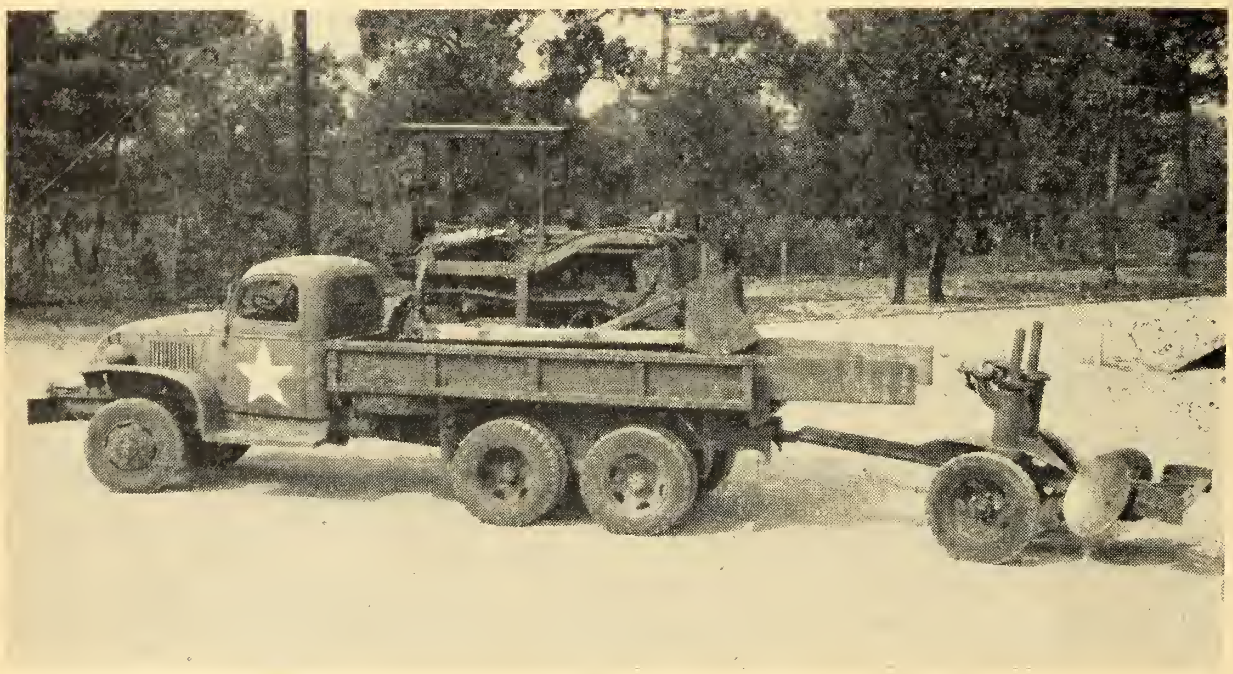
A type A–6 fuel-transfer unit has been mounted directly on this trailer to increase its efficiency in refilling trucks. The unit has a large volume discharge, which enables it to pump considerably more water than the pumps on most of the trucks.

The ¼-ton jeep trailer, which was originally designed as an experimental trailer for use with the ¼-ton reconnaissance car (jeep), has been adapted to use as a carrier for the Pacific Marine Pumper, its fittings and hose. The sides and gates were made of plywood and the containers for the pumper and 1,000 feet of hose can be removed from the trailer. Wooden cleats were fastened to the floor of the trailer to hold each box in place. A cover was made for the entire trailer and its cargo and no other adaptations were necessary.

Mobile Fire-line Plow Unit

The Mathis two-disk fire-line plow is the best tested for this area. Used with the International tractor, T–6 or T–9, this plow makes a very efficient unit for fire-prevention and fire-suppression work. On fire-prevention work, the T–9 tractor is more desirable as it has more power and wider tracks which enable it to plow lines faster and farther into the edges of the swamps and on more marshy lands. The T–6 proved to be a more desirable tractor for use with the Mathis plow in fire-suppression work. It can be transported on a 2½-ton truck, which carries skids and pulls the Mathis plow mounted on pneumatic tires. On suppression work the plow can be disconnected, the tractor unloaded and rehitched to the plow and ready for use in 7 minutes.

On fire suppression, this plow has been most effective when following one of the larger water trucks to plow a line around the fire at the edge of the burned area. This greatly reduces the number of men required for patrol and mop-up. The plow is also used to prepare lines from which backfire can be started safely and to reach places which are inaccessible to the trucks. In wire grass it is often possible to stop fires with a plowed line, in places where trucks cannot always be operated.



International T–6 tractor and bulldozer loaded on 2½-ton G. M. C. cargo truck trailing Mathis two-disk fire-line plow.

Specifications of Equipment Tested

	1½-ton cargo truck	¾-ton weapon carrier	½-ton pick-up	¼-ton jeep
Make	Chevrolet	Dodge	Dodge	Willys.
Capacity ……tons	1½	¾	½	¼.
Driving wheels	4 x 4 (2–DT)	4 x 4	4 x 4	4 x 4.
Tire size ……inches	7.50–20	9.00–16	7.50–16	6.00–16.
Pump	Panama and Yale-Towne.	Panama	Panama	Compressed.
Tank capacity ……gallons	500	200	120–175	40.
Hose, discharge ……inches	¾	¾	¾	¾.
Hose, suction ……inches	1	1	1	¾.
Nozzle tip ……inches	0.20 and 0.14	0.14	0.14	0.07.

SMOKE MASKS AND GOGGLES

Oley Scott

Mark Twain National Forest, U. S. Forest Service

Almost everyone with experience on the fire line remembers instances where a flare-up might have been handled and the break-over prevented if the crew, or only one good fire fighter, had kept on pitching even for a fraction of a minute. But the eyes and lungs couldn't take the acrid smoke any longer. The devices here described are not burdensome or hampering, and if they were more generally used, probably much less lost line would be reported.

In 1942, experiments were begun on the Mark Twain National Forest with the use of smoke masks and goggles by fire crews on close-in work on hot-spotting, burning out, or holding oncoming fire at a road or natural barrier.

The light fuels of oak leaves and grass had so much increased under protection that it was difficult to construct and hold a fire line on the higher danger days when the rate of spread was rapid because of strong and frequently shifting winds. Often, because of heat and smoke, crews had to fall back, with consequent loss of fire line, increased burned acreage, and discouragement of the fire fighters.

Various types of gas masks, respirators, and goggles were used experimentally. Trials showed that the smoke masks and gas-proof goggles permitted fireguards and fire fighters to hold a fire under conditions that would be intolerable without such protection from smoke and heat. It was found that protection of the eyes is as important as of the nose and throat and therefore the goggles must be gas-proof.

Standard Equipment

The smoke mask and gas-proof goggles are now accepted as standard equipment for fireguards and initial-attack crews on the Mark Twain Forest. Seasoned guards carry their masks at all times when on fire duty. Local crewmen who are repeatedly called to fight fires request this device as part of their equipment when hired for fire-suppression work.

When not in use, the mask is suspended around the neck and the goggles are pushed up on the head. It takes but a few seconds to adjust the device, which can be readily removed from the face when not needed.

Several types of masks and goggles that may be used in fire fighting are manufactured. The Mark Twain Forest has experimented with and found quite satisfactory Carter's combination gas mask and goggle and Cover's new gas mask and gas-proof goggles. Cover's goggles have a very effective device for preventing the lenses from fogging up. Each eye piece has a water chamber that should be kept filled; a nod or shake of the head clears the glasses of moisture.

The Army goggle M–1944 is now being tried, but until it is used more extensively on actual fires, no definite recommendations can be made.

HELICOPTER HOPES FOR FIRE CONTROL

David P. Godwin

Assistant Chief, Division of Fire Control, Washington Office, U. S. Forest Service

It's an exciting field of thought—the employment of helicopters in fire control and other forest activities. Hopes long cherished but often dim are being renewed as technological advances take on the shape of reality. As the development of the hovering type of flying machine—known to the aeronautical profession as rotary-wing aircraft—moved forward by slow and painful steps, foresters began to dream of the revolutionary effects it might have upon their present ways of doing the field job. It seemed like a vehicle built to order. In the early 1930's we had a few opportunities to use the autogyro over some of the western areas. But the autogyro was a transitional type and did not free itself of the basic elements of the airplane. Now comes the helicopter.

Development of the Helicopter Principle

The pure helicopter principle has engaged scientific thought for centuries—Leonardo da Vinci designed one in the fifteenth century. But he, like hundreds of successors in this field, failed because of the lack of a sufficiently powerful force to lift or propel the machine. So it was not until well after the invention of the gasoline engine and some years after the first airplane flights that rotary-wing aircraft left the ground. In 1922, Bothezat, a Russian scientist, under contract with the United States Army, built his helicopter and made several short but successful flights. This was the real beginning of the practical development. The autogyro entered the field for a period and then under an appropriation from Congress in 1938, the Army Air Forces—acting for the military branches and a few civil agencies (including the Forest Service)—invited bids for design competition. Later, out of this action came the Sikorsky helicopter. In 1942, the Sikorsky XR–4 made its first flight and was the forerunner of the many war-inspired helicopters now in the air and performing, in the main, like grown-up airships and not toys.

During the past 2 or 3 war years there has been a ferment of design and production activity in this aircraft field, and now it is accelerated by the race to reconvert to peacetime requirements and compete in the commercial market just around the corner. Today there are about 50 aircraft organizations engaged in the manufacture or development of helicopters. This dramatic new development in air travel has excited the public interest; and due to Sunday-supplement articles, semiscientific magazine promotion, and the zeal of advertisers' artists, the whole thing has been overpromoted. Many people look forward confidently to buying soon a two-passenger job for about the cost of a flivver, or a chance to ride in a 50 passenger airline helicopter. For such people disillusionment is ahead.

Developments have reached a stage, however, where it can be said that the helicopter is the most versatile type of flying machine known to man, capable not only of vertical rise and descent within an area slightly larger than that swept by its rotors, but also of hovering, climbing, gliding, and flying forward, backward, or sideways.

Uses in Forested Areas

Because it can land and take off in very restricted areas, the helicopter could deliver men and supplies in thousands of spots throughout forested areas, such as flat ridge tops, small meadows or clearings, and in canyon bottoms. The Forest Service, if sufficient funds were provided, could extend the number of airplane landing fields beyond the approximately 90 now in use on the national forests, although topography would soon limit the number of available sites. Furthermore, the clearing and leveling of such sites is an extremely costly process. On the other hand, if perfected rotary-wing aircraft were available, there would be almost no limit to the number of small landing spots already provided by nature or which could be inexpensively prepared. With such an air-ground transit system, small well-trained and equipped crews could be transported to spots at or near small fires very quickly after discovery and report.

The helicopter would also have many other forest uses. On large fires men could be shuttled back and forth between fire camp and fire line, and prepared food taken to the fire fighters on the job. For various types of observation such aircraft has no equal. These include detection of fires, scouting project fires from the air, and prevention and law enforcement in areas where incendiarism gives trouble. Helicopters would be ideal for search and rescue work, livestock and game counts, and for survey and administrative travel in connection with range and timber management.

Most of the federally protected forest areas lie in the western mountains and are rough and relatively inaccessible. Millions of dollars have been invested in roads and trails constructed primarily and in some cases purely for fire protection. The large annual maintenance cost of these ground-transportation systems is an additional financial burden. A well-planned and skillfully managed helicopter operation conceivably could provide a degree of protection justifying a reduced road-building program and abandonment of some existing routes.

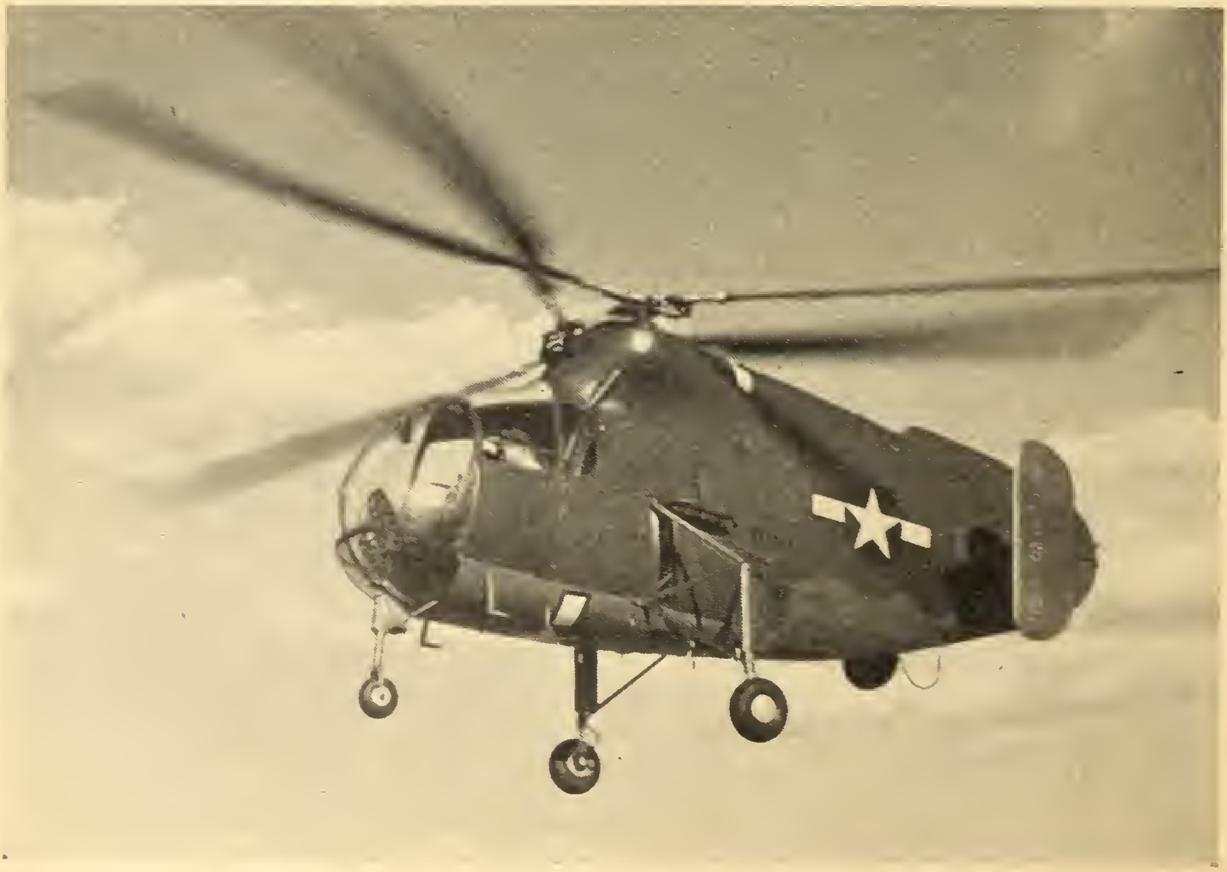
Given certain assumptions as to helicopter performance, such as pay load, hovering and service ceilings, cruising range, speeds, and operating costs, it should be relatively easy to prepare a helicopter fire-control plan. Actually, several of our western regions have selected sample areas and worked out on paper and maps the location of hub or operating points, degree and time of coverage, suitable dispatching schemes, the elimination of existing facilities and personnel, and have set up rough comparisons of the costs of the respective systems.

Prospective Designs

The aeronautical principle of the helicopter has been proven beyond doubt, but mechanically there is a different story. Much has yet to be done to remove the "bugs" from the complex mechanisms. Corrections and refinements must come in rotor-blade construction, power transmission, and the hub design and assembly, and lighter and stronger metals must be employed. Another important and interesting time-taker in this feverish evolution is the matter of arrangement and number of rotors, which the aircraft designers call "rotor configuration." A struggle is on between the advocates of these different helicopter conceptions. A great number of configurations have been worked on, but basically there seem to be about a dozen. No doubt these will shake down to less.

We laymen are easily lost in these aeronautical competitions and prophecies as to which rotor schemes will survive, but it is possible to state oversimply what the present outstanding patterns are. There appear to be about six: (1) Single rotor with tail rotor to counteract torque as in the Sikorsky helicopter; (2) two rotors mounted on either side of the fuselage but clearing as exemplified by the Platt-LePage machine; (3) two rotors mounted on either side of the fuselage but synchronized and intermeshing as demonstrated by the Kellett design; (4) two rotors mounted in tandem (fore and aft) but clearing as illustrated by the Piasecki; (5) two rotors mounted in tandem but overlapping in sweep as exemplified by the Magill; (6) two coaxially mounted rotors (one superimposed above the other) as in the Hiller or the Bendix.

Together or singly, P. A. Thompson and I have visited the plants of six leading helicopter manufacturers to make a rough survey of the progress being made, to discuss with these men the possible forest uses of rotary-wing aircraft, and to fly in some of the models. Also, for a long time we have had contract with industrial designers and



The Kellett military model helicopter XR-8, which employs two 3-bladed intermeshing rotors

Sikorsky military helicopter R–5 which, with enlarged cabin, will be the basis for the Sikorsky commercial four-place model.

engineers and with officers of the Army Air Forces helicopter development section. We have familiarized industrial producers with our fire problems and fire-control methods which we believe the helicopter can improve upon, and invited them to demonstrate—under flying contract if necessary—what these machines can really do in the actual ground and air conditions presented by our rough mountain terrain. One or more will probably respond to this invitation during the early summer of 1946.

As is generally known, the three Sikorsky models were the only helicopters produced in quantity for the A. A. F. As roughly graded by their power, these are the R–4, 180 horsepower; the R–6, 235 horsepower; and the R–5, 450 horsepower. Several hundred of these were built and flown. The R–4 is a very light reconnaissance type and hardly suitable for any western forest work. The R–6 may have some applicability, but the R–5 is the most powerful, has fine performance, and is the prototype upon which the first Sikorsky commercial model, the S–51, will be based. The following data on the S–51, which will probably be produced in moderate quantity in 1946, help to visualize what the machine is like and can do:

Performance

(In NACA Standard Air)

High speed at sea level	miles per hour	103
Cruising speed at 65 percent brake horsepower	do	80
Minimum flying speed	do	0
Maximum rate of climb at sea level	feet per minute	1, 200
Hovering ceiling	feet	3, 500
Service ceiling	do	13, 000

Fuel consumption (cruising) approximate 28 gallon per hour.

Load Distribution

(Cruising range 150 miles)

Fuel (70 gal.)	pound	420
Oil (6.7 gal.)	do	50
Residual fuel and oil	do	30
Pilot (1)	do	170
Passengers (3)	do	510
Baggage	do	70
Useful load	do	1, 250

Weights

Gross weight (design)	pound	4, 900
Useful load	do	1, 250
Empty	do	3, 650

Changing the employment of this useful load to a distribution more suitable to our fire-suppression crew needs, the 500 pounds of fuel could be reduced to 350, thus releasing 150 pounds to be devoted to personnel and equipment. This would cut the cruising range down to about 100 miles but would permit the transportation of four men (including pilot) and 220 pounds of equipment. This is merely an example and leaves out of consideration the flying, hovering, and landing problems inherent in altitude.

The Piasecki PV–3 is, to my knowledge, the largest American helicopter. Its fuselage is 48 feet long and according to Mr. Piasecki it has flown with 10 passengers—unusual lift for a 550-horsepower engine. The model has been accepted by the Navy. Equal or greater weight-carrying capacities, we learn, are being projected by other builders. The biggest job we have heard of is the German helicopter, Focke-Achgens, powered with two 2,000-horsepower engines, which was in development during the war and the design of which was discovered and reported by a British Intelligence Mission. It was to mount two 55-foot rotors laterally, weigh 16 tons, lift 5 tons, and was intended to carry tanks and trucks across rivers and to hoist such loads as bridge girders into place.

Costs

What will helicopters cost? We ask that question frequently but there is no definite answer. It is quite understandable that manufacturers can as yet set no prices. Great expenditures for research and engineering have gone into present models which have been virtually hand-made. Even though all makes still have "bugs" to be worked out, it is likely that three or four leaders will go into moderate commercial production sometime in 1946 and at that time will quote. As production progresses, costs will decline and probably reach a point where helicopters can be had for prices 30 to 50 percent in excess of airplanes of equivalent pay load and other comparable characteristics. The difference in cost between the two types of aircraft will be the price that customers will have to pay for the unique performance which can be had in no other way. Because of the helicopter's inherently intricate mechanisms and vulnerable members, it is likely also that operation and maintenance costs will exceed somewhat those of comparable airplanes.

Helicopter pilots and mechanics are specialized, and due to the newness of this technology, few in number. They will come from the personnel of the Army or the manufacturers. In the whole country there are probably not 200 competent pilots. However, there is a surplus of airplane pilots, and questioning a number of authorities turns up a sort of average opinion that 30 hours of training is sufficient to make a helicopter pilot of a capable airplane pilot.

Tests in National Forests

We now have high hopes for an early comprehensive field program of test and demonstration of the adaptability of the helicopter to forest work under actual forest conditions. Last summer and fall many contacts were had with officers of the A. A. F. relative to the Forest Service proposal of military aid during the 1946 season, involving an experimental as well as operational project. The experimental project will include two phases: (1) Experiment and test to develop, if possible, a technique of effectively dropping fire-suppression materials from airplanes and (2) test and demonstration of the suitability of helicopter operation as a part of the fire-control system. The latter only is pertinent to this article.

The whole plan was approved October 23, 1945, and a directive was issued by the Assistant Chief of Air Staff, assigning to the Continental Air Forces the task of setting up the projects as a cooperative endeavor with the Forest Service. For the helicopter project March Field in Southern California was selected as the center of operations, and the Angeles National Forest as the proving ground. In December 1945, two R–6 machines with crews were assembled at March Field and at this writing four more R–6's are due to arrive and two R–5 machines are expected to be assigned. These are, of course, the military types but will serve fully to demonstrate the adequacy of helicopter performance under those conditions.

The work plan provides for a series of tests to determine the limits of combinations of conditions, including load, topography, altitude, weather, and cover within which satisfactory performance can be obtained. These will be combined with or followed by tests of practical application of the helicopter in the many and varied proposed uses in Forest Service work. The results of these operations, which could be provided us only by the A. A. F., should put us far ahead in our knowledge of how we can employ this new scientific development.

So far helicopters have not flown our forested areas. Flights in a few comparable conditions have been cited, but comparisons and simulations are not definitive; and until these airships maneuver over our actual terrain and do the things we require of them, we will not know. The first tests with existing models may not be entirely conclusive, but if they are only fairly successful, we feel confident that in a reasonably short time the pending improvements in the mechanical elements will round out a vehicle that will mark a turning point in the progress of forest transportation.

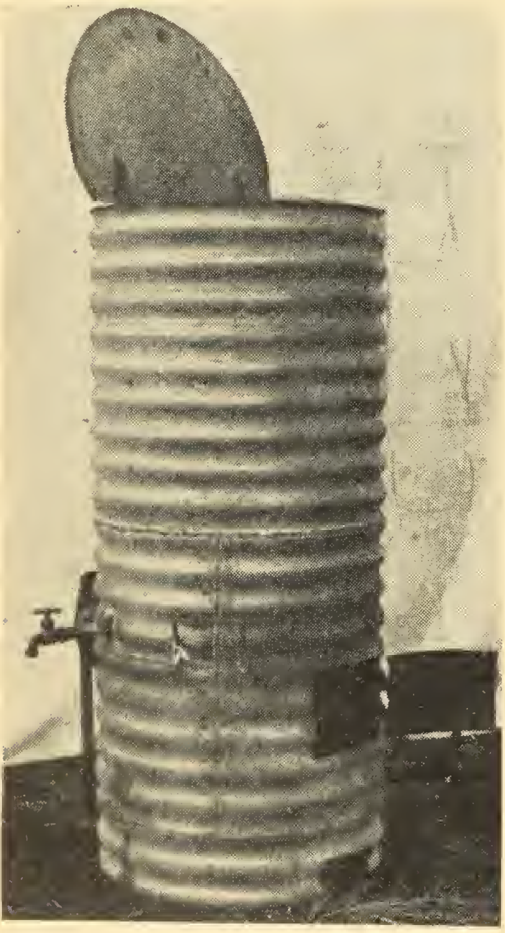
PORTABLE WATER HEATER

Curtis E. Price

Forester, Siskiyou National Forest, U. S. Forest Service

The Siskiyou National Forest has tried a number of water heaters and, for use at large camps, has settled upon one made from culvert material which can boil 60 gallons of water in 35 minutes from the time of filling. Ordinarily, with most heaters it takes an hour to boil 60 gallons.

The heater is made from 24-inch culvert material and weighs a little over 100 pounds. The seams are welded and a partition, which serves as the top of the firebox and the bottom of the reservoir, is welded in. The total height is 56 inches, and the top of the firebox is 20 inches from the ground, which serves as the firebox floor. A notch 3 by 6 inches is cut at the bottom for draft. A fuel door 7 by 10 inches is cut near the top of the firebox and hinged as indicated. A collar is welded to the upper edge of the firebox at the rear to take a 6-inch stovepipe elbow. Three joints of pipe are ordinarily used. The top of the reservoir is closed with a hinged lid to keep out leaves and trash.



View of portable water heater, showing fuel and draft openings, carrying handle, faucet, cold water pipe attachment, and stovepipe elbow.

A total of 28 feet of ¾-inch pipe is used in making the coils. Three turns around the firebox are placed between the draft opening and the fuel door, and six lengths across the back half of the top of the firebox. Return bends are used in making up the latter and the lengths are, of course, progressively shortened as the side of the cylinder is reached. The cold water attachment to the coil enters the reservoir just high enough to clear the bottom.

The hot water entrance to the re. servoir is 8½ inches above the bottom- Its location would not seem to make any difference, but Al Love, who designed and constructed the heater, says that after considerable experimentation it was concluded that heating efficiency was greatest with the location as indicated. Various lengths of coil were tried, and the arrangement described gave the best results.

DDT—FIRE-FIGHTERS' FRIEND?

H. T. Gisborne

Northern Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service

Can DDT, the new miracle insecticide, make living conditions more pleasant and healthful around fire camps? That is the question Region 1 set out to answer last winter.

Early in April 1945, 5 pounds of the powder was distributed by the region to several national forests with instructions for its preparation (solution of 1⅓ ounces of powder in 1 quart kerosene) and use. The plan provided that each forest in April or May count the number of flies, yellow jackets, mosquitoes, etc., found at each of two cookhouses or bunkhouses in a given locality; spray one unit and leave the other untreated; and report on form sheets the numbers and classes of live insects found 1, 2, 3, and 4 weeks after spraying.

Although the results were insufficient to warrant generalization, primarily because April and May were exceptionally cold and there was an abnormally scanty insect population at most stations, the possibilities of DDT as a friend of fire fighters were indicated.

Treated and Untreated Rooms

The report from Spotted Bear Ranger Station is typical. Before spraying, there were 20 live insects in the unit treated. One week later, there was none; 2 weeks later, one; after 3 weeks, none; and after 4 weeks, two. By contrast, in the untreated room there were 18, 24, 20, and 25 live insects after a lapse of 1, 2, 3, and 4 weeks, respectively.

Supplies of DDT powder were later furnished to several forest officers for use at fire camps. The one report received was highly complimentary but indicated that after 4 or 5 days less effect was apparent. This means either that the initial spraying had been inadequate or that the presence of a fire camp brings a very material influx of flies.

Tests were also made at two lookout stations, where flies and flying ants are sometimes a great nuisance. Results from merely wiping the sills and rails of the windows were remarkably good. One of the rangers immediately asked for enough DDT to treat all of his lookout houses next year.

No harmful effects have been observed in handling DDT, although at least one man has had his hands thoroughly covered several times by the dry powder.

GRAVELY FIRE-LINE BROOM

Albert Howard

General District Assistant, Houston Ranger District, Mark Twain National Forest

The Gravely tractor with rotary broom attachment was tried out on line construction in leaf-type fuels during the spring fire season of 1945 on the Houston Ranger District, Mark Twain National Forest, after original use on the Shawnee National Forest. Considerable information was obtained and definite conclusions reached which are of value in the future use of this piece of equipment.

Description of Tractor

The Gravely tractor, manufactured by the Gravely Motor Plow & Cultivator Co., Dunbar, W. Va., is a small two-wheel rubber-tired garden-type tractor, with five or six different attachments, such as plow, mower, rotary broom, etc. The broom consists of ten 24-inch sections of 6-inch fiber brushes, having an over-all width of 33 inches and diameter of 16 inches. It has a high and low rotary speed. Power is furnished by a 5-horsepower, one-cylinder, air-cooled motor. The tractor has two speeds forward and one reverse; over-all length is 92 inches and height to handle bars 40 inches. It operates on two wheels with rubber tires size 4.00 x 8. A walking operator handles the controls.

Use In Fire-Line Construction

During the 1945 spring fire season, this unit was used on initial attack on two class "C" and three class "B" fires. The crew on three fires consisted of one man in front with the rotary broom and two following to clean and widen the fire line. On two fires, the crew comprised five men, a boss, one with rotary broom, two cleaning and widening, one back-firing, and two patrolling and scouting. The indirect method of attack was used on all fires and rate of spread determined the distance between line and edge of fire.

The machine was used in four different fuel types:

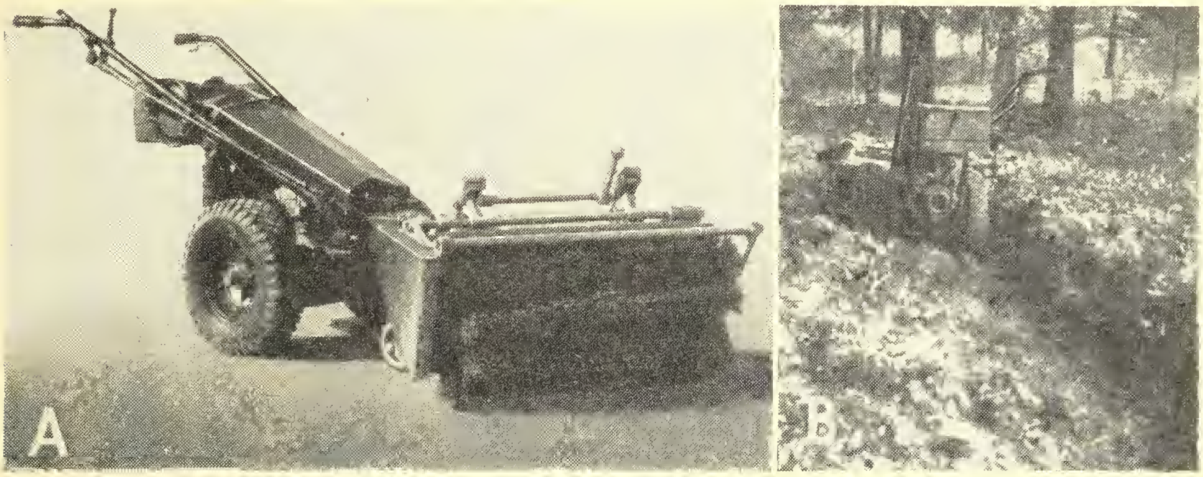
(1) *Short grass and weed fields.*—Here it was of no value because the rotary broom sweeps only loose material, such as leaves, and does not dig into the soil, as is necessary in grass. It simply bent the grass over, but did not clear any line.

(2) *Dense southern hardwood reproduction.*—In this type its use is limited, owing to the difficulty of maneuvering the machine through dense reproduction, but more particularly to the broom's inability to sweep a clean line. Short stubs are left from line clearing.

(3) *Fully stocked upland hardwoods and hardwood-pine types.*—Performance of the machine in this type was considered satisfactory. Line constructed was equal to four well-trained men with hand tools.

(4) *Upland open southern hardwoods.*—Here the Gravely broom made an excellent showing. The line constructed was down to mineral soil, and no cleaning with hand tools was necessary. It was possible to construct as much as 60 chains an hour with an estimated average of 30 chains per hour for all fuel types except grass fields.

The Gravely fire-line broom was used on slopes varying from 0 to 25 percent. Effectiveness on slopes above 15 percent was noticeably reduced when using rubber-tired wheels, due to lack of traction rather than lack of power. However, new cleated steel wheels have been purchased which it is believed will increase the unit's effectiveness on steeper slopes.



A: View of Gravely rotary fire broom. Note covered chain drive. F-433130.
B: Fire line, 18 inches wide and 90 percent clean, built by Gravely rotary broom in leaf fuels. F-433135.

The Gravely broom is easily loaded and unloaded by using two wooden runways and driving it into the pick-up under its own power. No great mechanical skill is necessary to operate and maintain it. Nor does it require much training to make a satisfactory operator out of the average fire fighter. Because of the shortage of fire fighters it was a very valuable tool during the past season.

Possible Improvements

Several possibilities are to be explored in improving the Gravely broom. An intermediate speed between high and low now available seems necessary. Some testing of wire or steel brooms, as against the fiber broom, also is desirable. Dirt and other debris cast up by the broom are thrown into the drive chain and gear, which should be moved to the other side of the machine.

TRAINING IN FIRE-FIGHTING TACTICS[1]

Glen R. Durrell

Director, Division of Forestry and State Parks, Oklahoma Planning and Resources Board

Here is an idea that can make training in fire tactics and fire strategy a lively and stimulating game. Every trainer would want to develop it a little differently to fit the particular needs of a specific group. But it has some elements that could be adapted to a variety of fire problems. Since it is essentially a graphic method, the description here cannot give a very complete picture of it. The author has agreed to send a limited number of samples of the cards and other devices he uses to readers particularly interested, in order to help in this respect.

In recent years there has been a steady advance in methods of constructing fire-control line, in equipment, and in training programs to increase the efficiency of the fire fighter in the production of held line. These are techniques that can be demonstrated, practiced, and used.

Our efforts at training in tactics and in fire-fighting generalship are largely confined to discussion, to analysis of disastrous fires, and to the school of experience. There is, of course, no substitute for experience, but when experienced men are not available it is obvious that we cannot set fires of the type our fire bosses must learn to handle in order to give them the necessary training.

Tactics Analyzer

To help meet this need in our Oklahoma organization we have developed what we call the fire-tactics analyzer. Expressed in simple terms it consists of plotting alternately the increment of the perimeter of a fire and of the control line by 15-minute periods.

Two rate-of-spread scales have been prepared for each fire-danger class; one for the burning period, the other for the night period. These scales show the spread of the head, flank, and rear of the fire by 15-minute periods. For a given fire-danger class in our particular area, slope is the principal factor affecting rate of spread. Therefore the scale is calibrated to show the distance the fire would travel down a steep slope, down a moderate slope, on the level, up a moderate slope, and up a steep slope for head, flanks, and rear in 15 minutes.

Another set of scales shows the amount of line that can be constructed in a 15-minute period by crews of various sizes, by direct and indirect attack, and by the various types of power equipment in use. Scales also show backfiring rates for trails and streams and for day and night travel for men and equipment, on trails and in the woods. For convenience, all scales are plotted on a basis of 16 inches to the mile. For training purposes, these scales were mimeographed on cards which show map distances in feet. A separate card was made for each danger class with the scales for daytime on one side,

---

[1] Reprinted from *Journal of Forestry*, February 1945.

and for night rates of spread on the reverse. Separate cards were made for each of the line-construction methods, for backfiring, and for rates of travel. This diversity allows the fire fighter to use only the scales applicable to the problem at hand. For office use we find it convenient to scratch all of the rate-of-spread scales on one sheet of celluloid and the line-construction scales on another.

How the Device is Used

To use the device we first select the section of land on which the fire is to occur. We then refer to topographic and fire-control maps, and make a drawing of this section on a scale of 16 inches to the mile, using standard colors to show all contour lines, roads, trails, streams, and any other features that might affect the spread or control of a fire. A set of conditions is next agreed upon, including point of origin, time of day fire started, class-of-fire day, wind direction, elapsed time from start of fire until crew arrives, size of crew, and power equipment available. The proper rate-of-spread scale to fit these conditions is selected and the fire area is plotted in red lines on the map by 15-minute periods to represent its size and shape at the time the crews arrive.

The fire fighter then studies the problem on the map, selects a point of attack, and using the proper scales, draws in with a green line the amount of control line he could construct in 15 minutes with the number of men and the equipment assigned to him. The fire is then expanded by 15 minutes and the next 15 minutes of control line drawn in. This alternate drawing of fire line and control line continues until the fire is surrounded. (To plot the fire accurately at each 15-minute period, place a dot at frequent intervals out from the periphery, according to the slope on the map and rate of spread as shown in the applicable scale, then extend a line through all dots, thus establishing a new periphery.)

——0

——1 man, 66 feet

——2 men, 140 feet

——3 men, 223 feet

——4 men, 314 feet

——5 men, 412 feet

——6 men, 487 feet

——7 men, 561 feet

——8 men, 668 feet

Rate of line construction in 15-minute intervals with indirect attack.

The burned area and the length of time required for control are then calculated. At this point the fire fighter behaves just as he does in the woods; he mops his brow and breathes a sigh of relief.

The lesson has just started, however. This is the time to discuss "What would have happened if." If line was lost through failure to tie down one end, by poor distribution of strength, by failure to start the control line far enough in advance of a rapidly spreading fire, or for other reasons, the cost of the error is determined by replotting the control line on the same diagram, and the difference in area burned and time required are calculated. If no line was lost, alternate points of attack or distribution of strength may be plotted to demonstrate better methods. On other diagrams the cost of excessive

HEAD FIRE

———0	——Level, 198 ft.
——Steep Down, 59 ft.	——Moderate Up, 279 ft.
——Moderate Down, 118 ft.	——Steep Up, 396 ft.

FLANK FIRE

———0	——Level, 79 ft.
——Steep Down, 23 ft.	——Moderate Up, 119 ft.
——Moderate Down, 47 ft.	——Steep Up, 158 ft.

REAR FIRE

———0	——Level, 59 ft.
——Steep Down, 18 ft.	——Moderate Up, 89 ft.
——Moderate Down, 35 ft.	——Steep Up, 118 ft.

Rate of fire spread in 15-minute intervals on a class-3 day, 10 a. m. to 6 p. m.

elapsed time can be indelibly impressed, as can the value of extra men and equipment. This kind of a session can be held on every fire fought on paper. The answers are positive and impressive.

Two general rules are followed in plotting the fire and control lines. First, tactics or equipment must not be used on paper in situations where it would be impossible to use them under field conditions. Second, the answer to almost all other questions that will arise depends on what the fire or the fire fighters would do in similar circumstances in the field.

Two methods may be used in setting up the problem: First, arbitrary selection to demonstrate a chosen set of conditions; second, selection by chance. Perhaps the second method does not have as much value as the first, but it does add a little zest to the work. For this purpose we use 13 pinwheels. Each dial sets up one condition. These dials are labeled fire danger class, wind direction, time fire started, part of section, section, township, range, discovery time, location time, get-away time, travel time, size of crew, and power equipment.

When the novelty wears off and the men become proficient in solving these problems under the conditions set forth thus far, we bring into play a fourteenth pinwheel, the "trouble wheel." It is divided into 32 sections, each one representing common conditions on the fire line. Some of the items are break-overs at various locations, arrival of volunteer help, loss of men, arrival of or loss of power equipment, changes in wind direction and velocity, etc. The spinning of this dial after each 15 minutes of control line is plotted gives valuable training in revising the attack to meet changing conditions.

Fire-control men may hesitate to attempt construction of the necessary scales for a device of this kind, and certainly scientists and researchers would have every right to question the accuracy of the figures we use, especially since we do not have danger stations in operation, and have not made any actual measurements of rate of spread or of line construction. We have not even defined in words the dividing line between moderate and steep slopes. Our figures are based on experience and observation plus a fair percentage of logic.

Results

Our concern as to the accuracy of the figures is not nearly as great since the device was put into use as it was at the start. We have found that when the same problem is assigned to several men there will be remarkably close similarity in the computed spread of the fire. We have plotted on paper a number of fires previously fought in the field, using the same set of conditions that occurred and the tactics employed at the time. The computed size and shape of the fire and the number of hours required to complete the control line check with such field experience within reasonably close limits. These two tests have convinced us that the scales are accurate enough for training purposes in the limited area for which they were designed.

It is recognized that for other areas the influence of fuel types, resistance to control, fatigue, and perhaps other factors may have to be considered in building the scales for rate of spread and control-line construction.

Of course, the real test of the value of this kind of training is in the results obtained in the field. Such results are hard to measure in a short period of time. We do know that when several men are given the same fire problem on paper the results in acreage lost will reflect quite accurately the amount of field experience each man has had. We know also that the results on paper improve as the man fights more "paper" fires. It is our hope that some of the paper experience and lessons will carry over into field practice.

In addition to training in suppression tactics, use of the device automatically trains the fire fighter in map reading. If the problems are set up in the area to which he is assigned, as they should be, he will gain considerable additional knowledge of his territory.

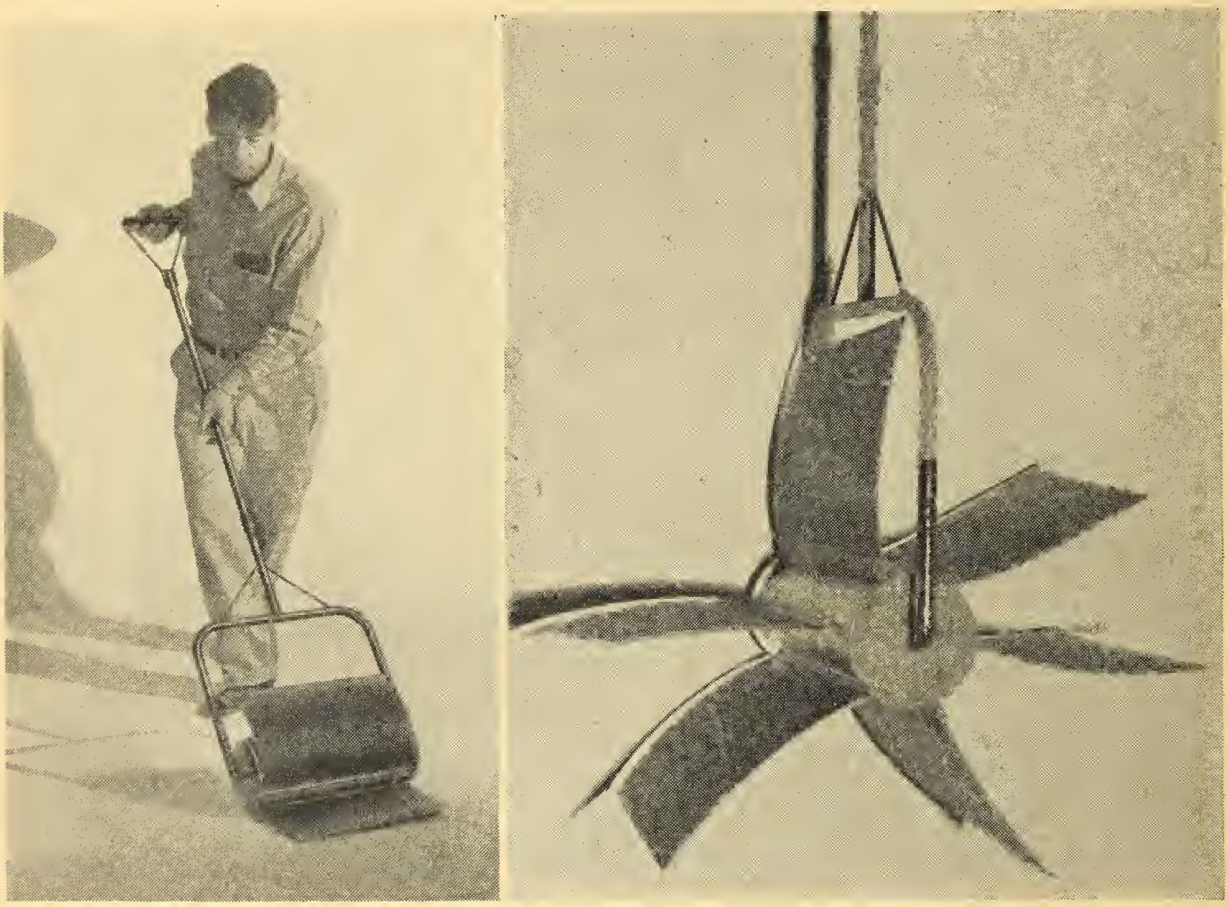
As knowledge of rates of spread and of rates of construction of control line accumulates, and as first control maps are improved, we believe that increasing use can be made of the analyzer by the dispatcher and the fire-control planner.

ROTARY FIRE MOP

Philip H. Murphy

Assistant Ranger, Helena National Forest, U. S. Forest Service

This rotary fire mop is probably the only hand-operated fire-control unit that generates and applies its own flame-suppressing energy and in volume and effect simulating water under pressure. It is specially designed for the suppression of flame in grass or stubble-type fuels on relatively open fields and range, but is equally applicable to flame of this type in standing timber.



Murphy rotary mop in use (left) and close-up of mophead (right).

The device is solid and durable. With the exception of the flaps, it is of all-metal construction. No screws, bolts, or nuts are employed in its assembly; nor belts, gears, pulleys, chains, or the like that invite wear and tear. Maintenance is confined to the replacement of a flap on rare occasions. Servicing only calls for greasing of the two journal housings once annually.

How the Mop Works

The mop is easy to operate. The separate but simultaneously produced powers, obtained from tension and centrifugal force, are draft, flailing or striking, smothering or blanketing, and crushing. Flexible flaps provide a continuity of suppressive energy. The flaps are fixed to an axis so as to permit each, when in action, first to store energy in the form of tension and then to release the tension suddenly and augment its power by centrifugal force.

The rotary mop is propelled along the flame line like a lawn mower, either forward or backward, in an upside-down or right-side-up position. It converts the simple process of walking to flame-suppressing energy, and applies it directly to the fire.

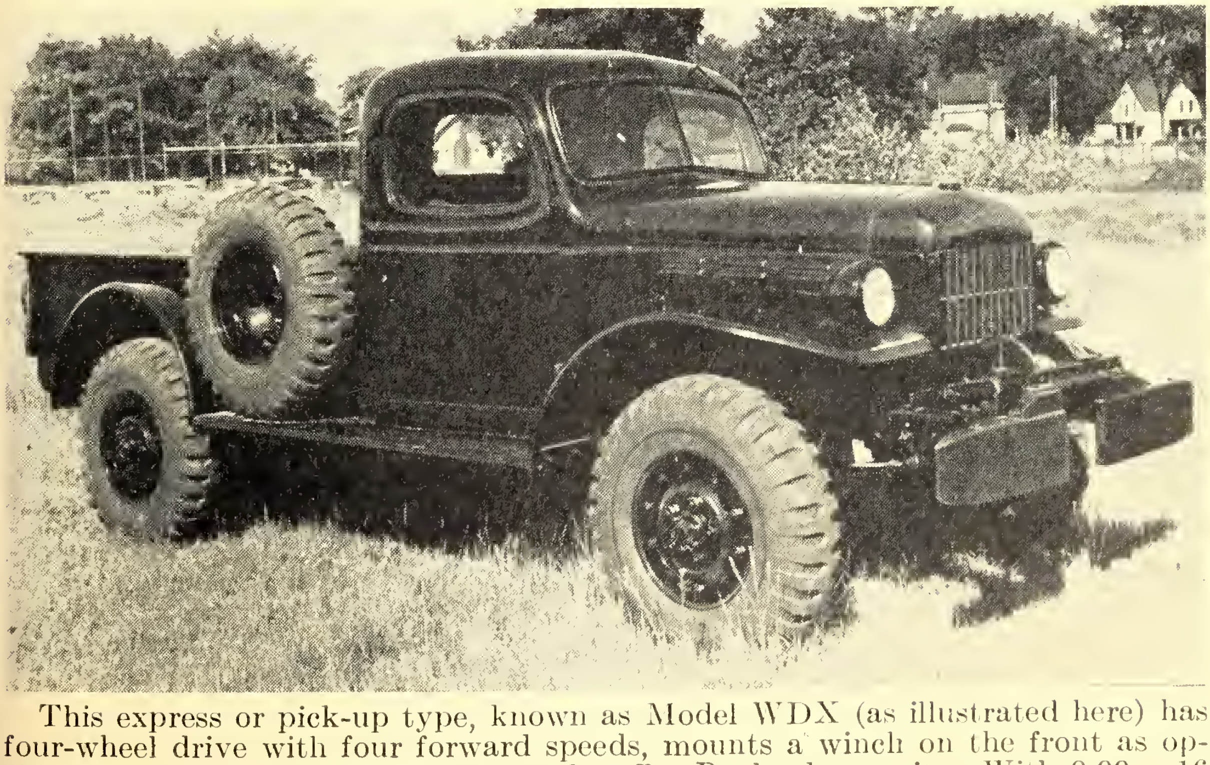
In the hands of an energetic operator it can suppress flame much faster than the conventional hand tools. Because of its caterpillar-like movement, the mop readily surmounts any obstacle equal to its own diameter. While in operation, it continually projects its own smooth tread, over which it may progress and simultaneously recover the tread after passing. The projected tread provides for its own traction and prevents skidding. Angular flap ends encourage the force of the created draft to "blow" hot ash and sparks onto the burned-over area. The tool is effective for the mop-up of punklike fuels.

Specifications

Because expansion of its principles is unlimited, no dimensional specifications apply. Model 5–15–A weighs approximately 23 pounds, and has an over-all length of about 72 inches and width of 17 inches. The 6 flaps each have a surface area of about 180 square inches, and the smothering surfaces at maximum operation are constantly at 225 square inches. Patent is pending. The cost is $24.50.

Postwar Truck.—Those who have observed military automotive equipment have been struck with the sturdiness and efficiency of the ¾-ton weapons carrier and its adaptability to fire-control work. Elsewhere in this issue appears an article on military equipment and Maj. Charles A. Rowland, the author, describes the simple conversion of the weapons carrier to a quick-attack light tanker.

The Dodge Brothers Corporation, makers of the weapons carrier, has developed a peacetime version of this vehicle and it is now in production. It is known as the 1-ton, 4 x 4, general purpose truck.



This express or pick-up type, known as Model WDX (as illustrated here) has four-wheel drive with four forward speeds, mounts a winch on the front as optional equipment and has a power take-off. Payload capacity: With 9.00 x 16 tires—3,000 pounds; with 7.50 x 16 tires—2,000 pounds.

FIGHTING FIRES WITH JEEPS

PERLE LEWIS

Forester, Clark National Forest, U. S. Forest Service

No piece of Army automotive equipment has been of greater interest than the jeep. The only jeep actually owned by the Forest Service during the war is the one described here. Hence it became a pilot model for adaptation to fire-control work. Observations of its characteristics and performance have applicability in every forested region.

On rough terrain the jeep has outstanding advantages over other automotive equipment. This has been demonstrated on the Clark National Forest.

A new Army jeep, assigned to the forest in the fall of 1942, has consistently enabled fire fighters to get to fires in considerably less time with resulting savings not only in acreage burned but in suppression costs.

In 2½ years, the jeep has traveled more than 21,000 miles in the more rugged part of the Ozarks, at elevations of 500 to 1,650 feet, with wide variations in topography and through timber stands that range from dense reproduction to old, mature trees. Here, veritable networks of old logging roads and skid trails exist, but are in advanced stages of disrepair. Heavy rains have transformed some of them into gullies, while others are almost obliterated by the growth of saplings. It has never been possible to keep more than a few main trails in a condition where regular trucks and pick-ups could be operated for fire protection. Moreover, the region is drained by numerous small creeks, bedded with gravel and sand and commonly crossed—except for the important roads—by fording.

Jeep Gets Them There

The jeep takes fire crews across terrain that is otherwise accessible only on foot or horseback. On one occasion, a fire was reported by radio to a stand-by crew with a pick-up, which was 2 miles nearer the fire than the jeep which left the ranger station at the same time. The jeep forded a creek and drove seven-tenths of a mile through the timber, arriving at the critical moment when the flames were beginning to eat into a field of dry sedge. The jeep crew stopped the fire—limiting it to 3 acres. The pick-up crew had to walk the seven-tenths of a mile through timber and came 15 minutes later than the jeep.

On another fire the ability of the jeep to get to the fire saved 2 hours of walking and 2 hours of crew time over that of a crew which used an ordinary dump truck for transportation.

In numerous instances the jeep, equipped with a 30- or 70-gallon tank of water, saved considerable time in the initial attack or mop-up because of the crew's ability to get the water right to the fire. Fitted with a 30-gallon tank, the jeep can carry two men, including the driver This has been very effective in the initial attack. Using the 70-gallon tank limits the crew to the driver, an arrangement largely used fo mop-up work.

Advantages of Jeep Over Pick-Up

Because of its construction, the jeep has numerous advantages over the pick-up. It can ford fairly deep streams because the breather pipe and oil filter openings are near the top of the motor block. Unless it is almost submerged, water cannot get into the crankcase. The generator is equipped with a hand latch which releases the fan belt when crossing streams, so that the fan will not throw water over the engine compartment. Streams two feet deep have been crossed easily.

The jeep can travel over rocky and rough country because it has more clearance than the regular pick-up or other fire trucks. Its construction gives the jeep more protection to the steering tie-rods and transmission than is found in ordinary equipment.

The jeep has proved equal or superior to any pick-up in economy of operation over similar roads. Finally, the absence of large fenders and cab makes it less liable to damage from brushy roads and deep ruts in cross country travel than other types of vehicles. The narrow tread enables the jeep to travel over roads with deep ruts, though not at high speeds.

Jeep Not a Cure-All

When all is said and done, the jeep is not, however, a cure-all for negotiating rough terrain. It has trouble following the contours of slopes with grades over 15 percent. On side slopes of this type, the jeep tends to slide downhill, often getting stuck between trees and other obstructions. This results in delay. However, it can make good time up and down hill on slopes of 20 to 30 percent.

The most serious drawback is the jeep's limited carrying capacity. It is rated as a quarter-ton, and under many conditions more men and equipment are needed for effective initial action than the jeep can carry. The answer to this problem seems to be the use of a larger vehicle of the jeep type, or two jeeps in the same action.

Revised Fire-Control Equipment Handbook.—A complete revision of the 1939 Forest Service Fire-Control Equipment Handbook was planned in late 1944, because of many recent improvements in (1) tools, equipment, and fire-control techniques developed by employees in the Forest Service; and (2) new types of power, transportation, and other equipment developed by the military organizations and private industries which were believed adaptable for effective use in forest-fire control. A national committee of representatives from the nine Forest Service regions in continental United States was convened at Washington, January 25, 1945. This committee discussed forest-fire control equipment needs and developments which had occurred since 1939, carefully reviewed the old handbook, and outlined plans and assignments to regions of contributions to be made, looking toward issue of a revised edition early in 1946.

During the latter months of 1945, much of the material for the revised handbook, in the form of rewrites of old descriptions and write-ups of new equipment items, has been reaching the Washington office. It is expected that all material for the revised handbook will have reached Washington and be edited and typed in the near future. The working committee designated by the national committee will thereafter convene at Washington to make a final review and arrangement of the material for delivery to the printer.

The handbook will be available to the public at the office of the Superintendent of Documents, Washington 25, D. C., at $1.25 per copy (tentative price).

SIMPLIFYING FIRE-FIGHTERS' MESS

H. M. White

Equipment Engineer, North Pacific Region, U. S. Forest Service

In recent years there has been considerable interest in simplifying the methods of feeding fire fighters. As early as 1939, concentrated rations were developed so that suppression crews on remote sectors of the control line could maintain themselves for 3 days and save hard, time-consuming travel between the fire camp and job. Meals prepared in central kitchens have been dropped from airplanes to fire crews in efforts to eliminate the delay and expense of setting up and maintaining cooking facilities at the fire. Some of these developments and experiments are described in previous issues of FIRE CONTROL NOTES.[1] Paper dishes have been used to a limited extent in order to reduce cost and overcome the danger of sickness from improperly cleansed tinware; but until recently satisfactory paper dishes were not available, and suitable disposable knives, forks, and spoons have not yet been found.

Experiments with disposable dishes and certain types of containers for dropping prepared food to fire fighters were conducted in the North Pacific Region in the summer of 1945. The results were sufficiently encouraging to warrant use of the equipment and methods on a wider scale in 1946.

Paper Dishes

In 1944 David P. Godwin made a rather extensive investigation of disposable dishes and found three articles, a partitioned plate, round utility dish or bowl, and cup with folding handle, that appeared to meet the requirements of being waterproof, heatproof, rigid, tasteless, and inexpensive. Six thousand of each item were purchased for trial on three national forests in the North Pacific Region. Descriptions and prices are as follows:

	Cost per 1,000
Chi-net 10¼-inch blue plate, code name "Lake"	$7. 88
Chi-net 16-ounce round utility dish, code name "Nimble"	6. 36
Flared 10-ounce cup, with handle in two parts which fold to either side for nesting	9. 44

The Chi-net products were obtained from the Keyes Fiber Co., Waterville, Maine, and the cups from the C. A. Reed Co., Williamsport, Pa. The prices indicated were f. o. b. shipping point. Transportation raised the cost to slightly more than 2½ cents per single set.

A large supply of plates, utility dishes, and cups was purchased recently from Blake, Moffitt & Towne, 17 Southeast Third Avenue, Portland, Oreg., at $9.33, $7.57, and $8.07 per 1,000, respectively. Plates and utility dishes are as described above, but the cup was an 8-ounce Dixie Cup (No. 108), with the same type of folding handle as the C. A. Reed cup, and of similar quality.

Three forest supervisors reported favorably on the paper dishes, and local cooperators, who have helped on fires for years, asked why the Forest Service had not used them before. Used exclusively in lieu of tinware on several fires, the cooks, camp bosses, and firefighters also found them satisfactory. The plates and utility dishes withstood moisture and heat very well, but the cup was considered a little light, having a tendency to lose rigidity after the second or third filling.

---

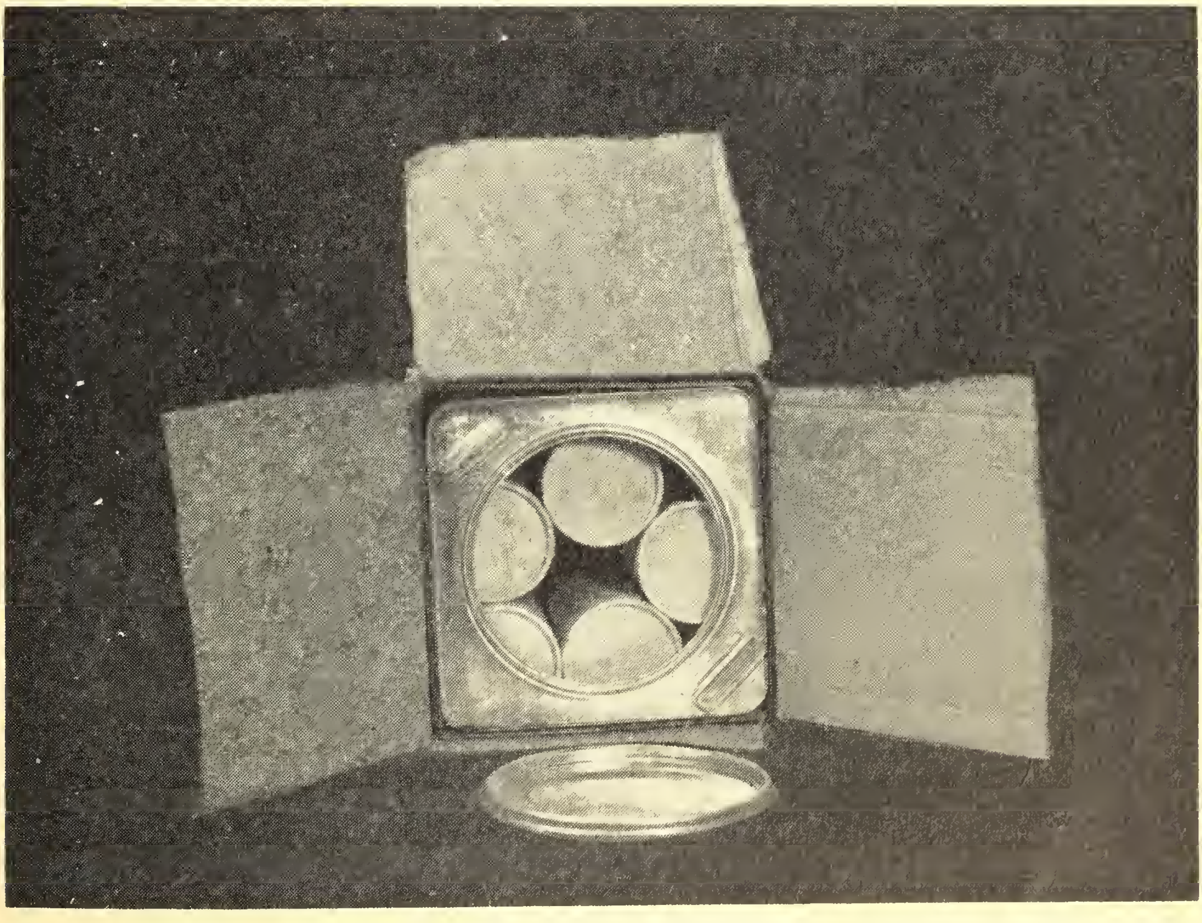
[1] April 1940, p. 49; July 1940, p. 116; January 1942, p. 22.

Paper dishes eliminate in part the cutting of wood, heating water, and hiring flunkies to wash dishes. From initial tests it is apparent that it costs less to use paper dishes than wash the usual tinware. In addition, sanitary dishes are assured at all times. An effort will be made to obtain satisfactory paper spoons and possibly forks and knives.

So far as known, paper dishes were not dropped from airplanes on any of the forests, but they obviously have an advantage over tinware for this method of delivery.

Dropping Hot Food Containers

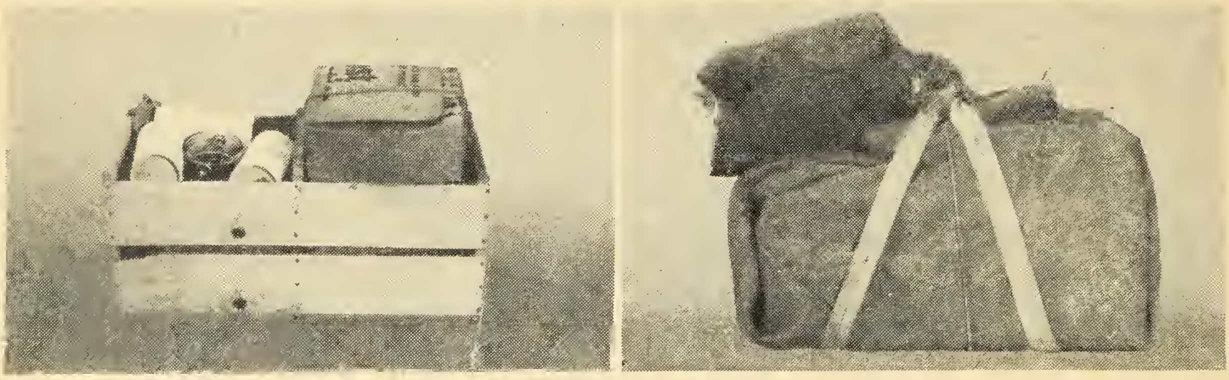
In December 1944, Floyd W. Godden, of the Intermountain Region, reported the successful use of ordinary 5-gallon gasoline cans for dropping liquids and 5-gallon friction-top honey cans for dropping prepared foods, such as scrambled eggs and bacon, cooked cereal, vegetable meat stews, etc. The cans were purchased complete with individual carboard cartons at low cost, and were left at the fire. Last spring a number of similar cans were bought in the North Pacific Region at 31 cents for the honey can and around 26 cents for the gasoline can, without cartons. Since the cartons could not be obtained, insulating and cushioning material had to be improvised.



Double-constructed carton used as insulation, 5-gallon friction-top honey can, and 1-quart cold storage locker containers. The can may be used for bulk food or to hold various foods placed in individual containers.

The honey cans were used for dropping hot meals to small crews at two fires on the Chelan National Forest. The gasoline cans were not used because a hot drink was not served, but, hot coffee or other liquid can be dropped successfully in such containers.

In one case the menu included steak, mashed potatoes and gravy, string beans, fresh milk, cinnamon rolls, and fresh fruit. While the food was being cooked the honey can, enclosed in a double-constructed cardboard carton, was set near the stove to absorb heat. The hot foods were put into 1-quart cold storage locker containers placed in the honey can in an upright position. The heated cinnamon rolls were also put in the can on top of the locker containers. The carton was then placed in one end of an orange crate, which is fitted nicely, with a 1-gallon jar of milk and fruit packed in burlap in the other end.



Left: Orange crate, with honey can in cardboard carton, and milk jar and locker containers packed in burlap. Folded burlap, not shown, was placed over the jar and locker containers. *Right:* The completed package, with parachute harness sling and silk cargo chute.

For the second fire, 4 gallons of meat balls and spaghetti in tomato sauce were put into a honey can without locker containers. The other half of the orange crate contained fresh milk, packed as before, and lettuce and tomato salad in locker containers.

In each case, the orange crate and its contents were wrapped in a piece of burlap 7 feet square and placed in a sling made of salvaged parachute harness. (The sling could have been made of rope, if parachute harness had not been available.) The packages were dropped safely with converted man parachutes. The weight of each package is not known, but undoubtedly it would have been a light load for a standard silk chute. Elapsed time in the first test was 3 hours, and in the second, 9 hours. On both occasions the cooked food was too hot for immediate consumption. There was enough meat balls and spaghetti for two meals for the crew. For the second meal the can was quickly heated over an open fire and the food was then as palatable as when freshly cooked.

In both cases, the food was dropped to smokejumpers who had individual mess kits. However, paper dishes could easily have been packed in the crate, with the milk and fruit or salad, by using less burlap packing.

THE SAND BOX AS A FIRE-CONTROL TRAINING TOOL

D. H. Euler[1]

Suppression Crew Foreman, Angeles National Forest, U. S. Forest Service

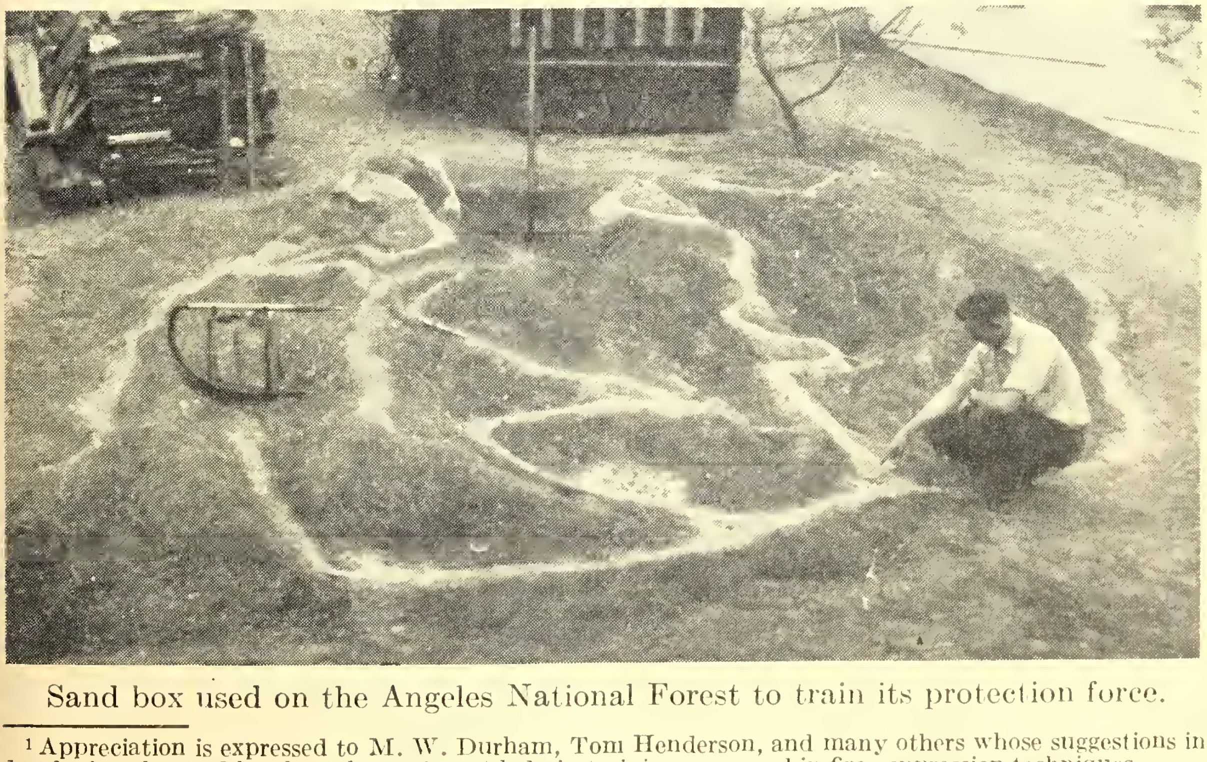
The two chief functions of the Forest Service protection force are fire prevention and fire suppression. The success or failure of our crews' performance in these functions is governed in large measure by the amount of training they get and its effectiveness.

Training in fire prevention and suppression is a technical job, and every available method and tool should be put to its fullest use. The sand table, film strips, motion pictures, and other training devices have been used effectively by the United States Army and Navy to train their personnel in the shortest time possible. Likewise in training large numbers of short-term forest protection men quickly, we have made many adaptations of new techniques to our specific purposes. Among them the sand box has proved quite successful.

The sand box is an adaptation of the Army sand table. But instead of a table holding sand for molding purposes, it is simply a mound of earth built up in the back yard of a ranger or guard station and shaped to simulate a real area with all its topographic features and various types of vegetative cover.

Angeles Sand Box

The Angeles sand box was constructed on an unused piece of ground approximately 30 feet square. Earth was piled with pick and shovel in the center and formed into every conceivable variety of ridges and



Sand box used on the Angeles National Forest to train its protection force.

---

[1] Appreciation is expressed to M. W. Durham, Tom Henderson, and many others whose suggestions in developing the sand box have been of great help in training personnel in fire-suppression techniques.

Close-up of sand box showing simulated topographical features.

canyons. The result was a miniature barren, mountainous wasteland, which represented roughly one township, according to scale. Roads and trails were outlined with white sand on the hillsides—dams, tunnels, and bridges adding a realistic touch. Miniature buildings simulating lookouts, guard stations, warehouses, tool caches, and settlements were constructed and spotted into the area. The miniature buildings were small blocks of wood roughly shaped and painted as were the lookouts, with pyramid top mounted on match sticks. A small village and public camp ground represented risk and places of fire occurrence. A flood-control dam in the canyon above the village helped bring out the importance of watershed protection.

With the sand box constructed and the culture prepared and located, some suitable fuels were required to illustrate the problems to be solved by actual burning of the cover. The fire was attacked in a safe and correct manner, bringing out points of attack; line location; and methods of control, such as direct attack, backfiring, etc. Various fuels were tried, including grass, pine needles, and light brush, with heavier brush stems to represent timber and logs. The pine needle cover was the best for burning, and dry grass most suitable for flash cover type of fuel. The shorter pine needles proved slightly better than the long needles, as the latter were "stringy" and difficult to keep off the roads and firebreaks, and added to the difficulties in teaching backfiring techniques. The heavier brush stems, simulating logs, added to the instructional value by rolling into unburned areas, smoldering after the fire had passed, and the like.

Before the sand box was used, the trainees were carefully schooled in the factors affecting rates of spread, such as relative humidity, wind, fuel moisture, temperatures, use of tools and equipment, and safety measures, in order to give them background and working knowledge of fire-control techniques. A preview of the specific problem to be worked out was given before the match was applied. Each problem was followed through from start to finish, encouraging the trainees to bring out all angles possible. After a major fire had devastated a good portion of the sand box watershed area, a fire sprinkler system was set up, the water turned on, and within a short time the erosion from a burned and an unburned area became evident.

Trainees Learn Readily

It is surprising how readily the trainees comprehend the manner in which the fire burns; the effects of various drafts; rolling materials; rates and direction of spread; and the convection of air currents created by ridges, peaks, and canyons; and other characteristics of full-sized fires. There is little hesitancy on the part of trainees to speak up when they recognize various points previously discussed in the classroom.

The problems which can be worked out on the sand box are endless. Where there is smoke, there is fire, and where there is fire the interest of the trainee is captured. Where there is interest, training is effective.

Conclusion

The development and use of the sand-box training system on the Angeles in 1944 has proven very successful and its use is encouraged and recommended. It should be stressed, however, that the sand box is not a plaything, or merely a game to pass the time away, but a definite training aid to be used in coordination with any fire-control handbook, and to study problems that have been or will be met on going fires. Further development and use of the sand box will bring improvements, and experimentation with various problems should be encouraged.

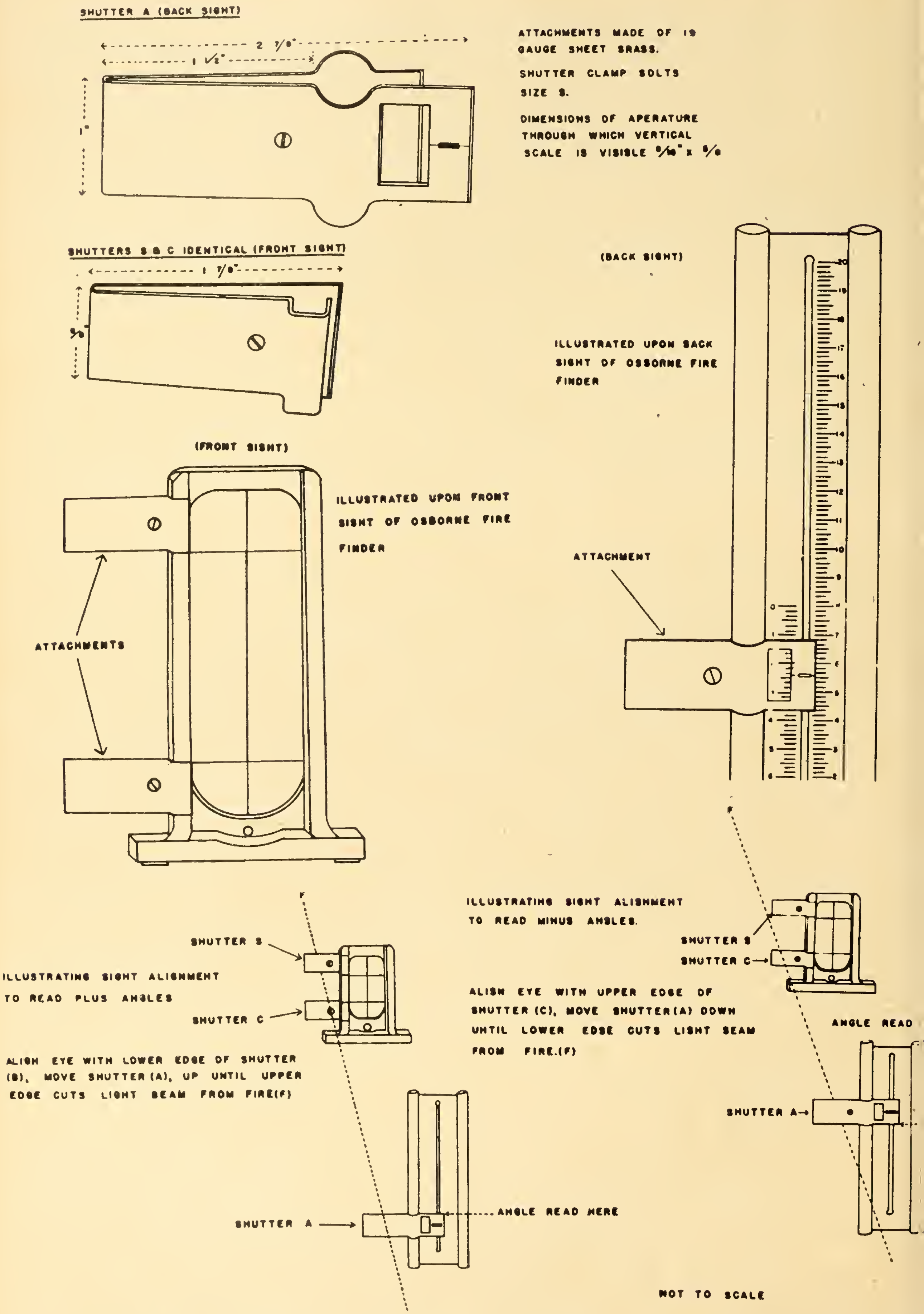
E. D. Reports.—At the meeting of the Fire Control Equipment Committee in Washington, January 1945, various forms of dissemination of equipment information were fully discussed. As a result of better organized equipment development throughout Forest Service regions, we receive, from time to time, comprehensive progress reports of items which have importance and general applicability. Because these are too lengthy and detailed to be used as articles for FIRE CONTROL NOTES, the Committee recommended that they be edited and mimeographed with multilith illustrations and distributed to field agencies.

These descriptive write-ups are labeled "E. D. Reports" and bound in a distinctive orange paper cover and numbered consecutively. So far the following have been issued:

Wescoatt Plow	E. D. Report No. 1
Michigan Line Builder	E. D. Report No. 2
Slip-On Tanker	E. D. Report No. 3
Army Jeep	E. D. Report No. 4
A Kapok Bed Bundler	E. D. Report No. 5
Ranger's Pal Plow	E. D. Report No. 6
Middle-Buster Plow	E. D. Report No. 7

These seven reports have been distributed in limited quantity to the Forest Service regional offices, the State foresters, and to certain Interior Department bureaus. It is regretted that wartime paper restrictions placed such severe limitations on quantity, but the geographic distribution is such that we believe interested readers of FIRE CONTROL NOTES will be able to borrow these listed reports from one of the offices mentioned without much difficulty. Later we hope to be able to get much fuller coverage in the distribution.—*Division of Fire Control, Washington Office.*

NIGHT ATTACHMENT FOR FOREST FIRE FINDERS


SHUTTER A (BACK SIGHT)
2 7/8"
1 1/2"
1"
ATTACHMENTS MADE OF 19 GAUGE SHEET BRASS.
SHUTTER CLAMP BOLTS SIZE 8.
DIMENSIONS OF APERATURE THROUGH WHICH VERTICAL SCALE IS VISIBLE 5/16" x 5/8
SHUTTERS B & C IDENTICAL (FRONT SIGHT)
1 7/8"
5/8"
(BACK SIGHT)
ILLUSTRATED UPON BACK SIGHT OF OSBORNE FIRE FINDER
(FRONT SIGHT)
ILLUSTRATED UPON FRONT SIGHT OF OSBORNE FIRE FINDER
ATTACHMENTS
ATTACHMENT
F
SHUTTER B
ILLUSTRATING SIGHT ALIGNMENT TO READ PLUS ANGLES
SHUTTER C
ALIGN EYE WITH LOWER EDGE OF SHUTTER (B), MOVE SHUTTER (A), UP UNTIL UPPER EDGE CUTS LIGHT BEAM FROM FIRE(F)
SHUTTER A
ANGLE READ HERE
F
ILLUSTRATING SIGHT ALIGNMENT TO READ MINUS ANGLES.
SHUTTER B
SHUTTER C
ALIGN EYE WITH UPPER EDGE OF SHUTTER (C), MOVE SHUTTER(A) DOWN UNTIL LOWER EDGE CUTS LIGHT BEAM FROM FIRE.(F)
ANGLE READ
SHUTTER A
NOT TO SCALE

The above drawings illustrate an attachment for the Osborne fire finder, designed by William Heckman, park ranger, Mount Ranier National Park, which permits more accurate readings of vertical angles on forest fires seen from a fire lookout during darkness. When using this item the observer, to determine a minus angle aligns his eye with the upper edge of the lower front shutter and moves the rear shutter down until the lower edge cuts the light beam from the fire. The plus vertical angle is obtained by using the lower edge of the upper front shutter and moving the rear shutter up to cut the light beam from the fire.

SCIENCE TRACKS DOWN WOODS BURNERS

Henry Sipe

Assistant Supervisor, Cumberland National Forest, U. S. Forest Service

Man-caused forest fires have been increasing in many parts of the United States. The best way to prevent them is to find and punish the guilty persons. This, however, is usually not an easy matter. Skill is needed in finding evidence, following up clues, and locating the woods burner.

For example, a fire occurs in the woods, and a path runs through the burned area. The investigator or ranger must guess whether the fire was caused by a smoker, a hunter, or an incendiary. A match or cigarette left behind will not alone lead to a solution of the case. The identity of the traveler through the area when the fire started must be determined, and his connection with the blaze established. If the cause of a fire cannot be definitely ascertained, it is likely to go into the category of "unknown."

Many investigations of the causes of fires are delayed until clues have grown cold or been obliterated, because suppression of the fire has first priority. Often insufficient time is given to the investigation. A further difficulty is that the investigator is not versed in the scientific detection of evidence.

Tool Mark Clues

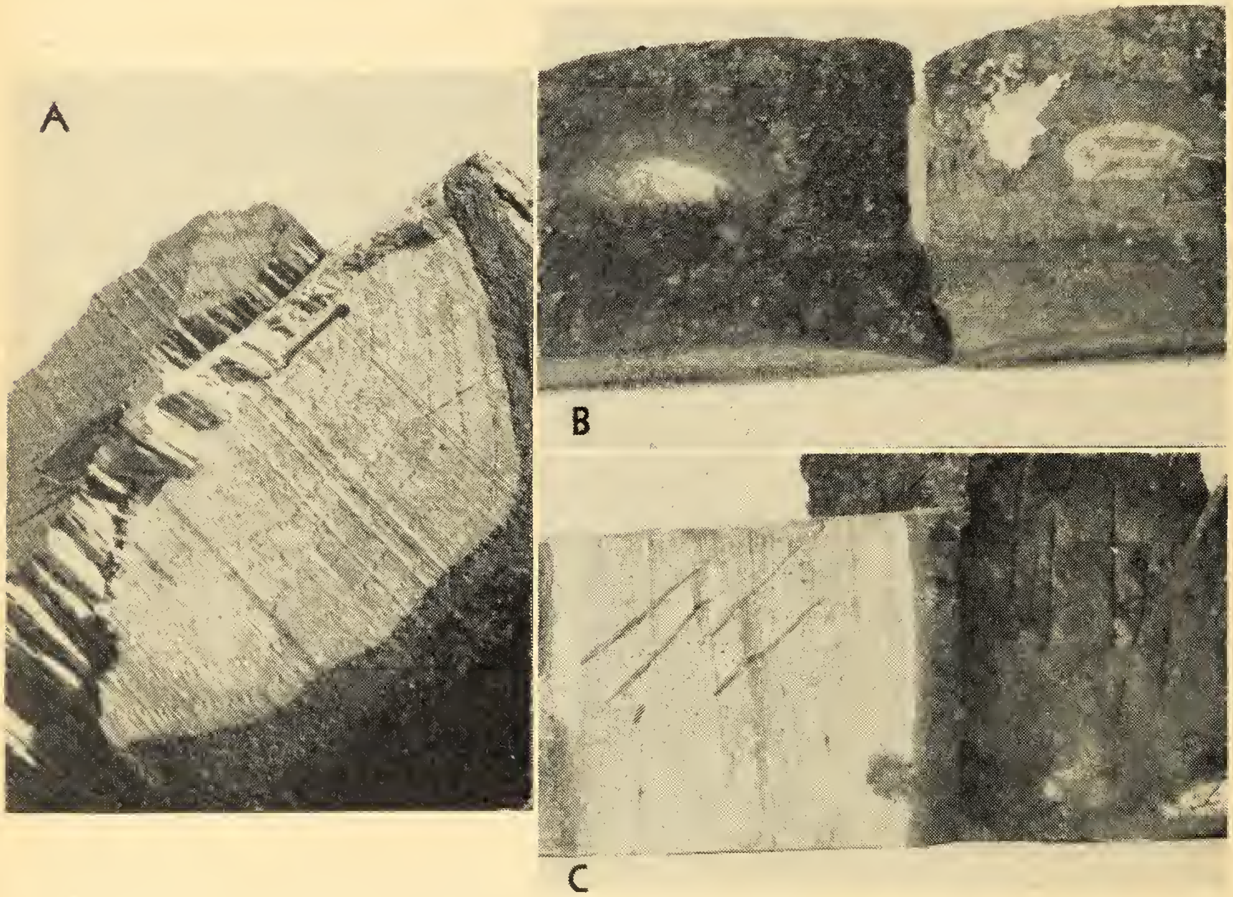
The scientific approach in determining responsibility for man-caused fires has proved quite successful on the Cumberland National Forest.

In one case, ax marks furnished the clue which led to the apprehension of a woods burner. Care must be exercised in comparing ax marks, in order to secure chips made the same way. The wood on opposite sides of a cut will differ in appearance, but close examination usually reveals certain similarities. When 10 acres of national-forest land in Estill County, Ky., were burned, a preliminary search by the fire boss failed to unearth any clues. An investigator, who arrived after dark, cross-sectioned the area thoroughly and found a moonshine still with fresh signs of a fire in the oven. Wood had been used for fuel, and ax chips showing definite nick marks were discovered. Pocketing a few chips, the investigator followed a dim trail to a house, where logs with similar marks were seen in the wood pile. Confronted with the evidence, the man of the house assumed responsibility and paid a fine. There have been no fires in that area since.

Telltale Prints

Tire, shoe, and fingerprints are among the most common and effective clues left by woods burners. A fire occurred on an old road used only by oil drillers. Tire tracks nearby showed print marks, similar to those found on a driller's truck tire. When questioned, the driller admitted being in the area the day of the fire and remembered throwing out a match near the burn. He pleaded guilty.

Another case where an ax mark provided the major clue occurred in 1943 on the Laurel district. A dead chestnut tree was found burning inside a burned area; beside it was a bundle of rags. A 6-inch hickory tree had been cut, trimmed, and used as a pry in an apparent attempt to uproot the tree; ax cuts showed identifying marks. Someone had apparently climbed a tree nearby. The investigator proceeded to the nearest residence a mile away. The man in the house said he had the flu and knew nothing of the fire except that he had seen the smoke. The investigator cut out a few chips with an ax he found at the wood pile and noted that the marks were similar to those at the fire. The man soon admitted that two boys had borrowed his ax to cut down a chestnut tree and when they returned it, had said, "We built a fire in the tree to smoke out a squirrel." The boys owned up and paid off.



A: Evidence leading to detection of a woods burner: two chips made with the same ax. *B:* Left, mark made on beech tree with suspect's mattock; right, mark found on tree on arrival at the fire. *C:* Left, cuts made with suspect's mattock; right, cuts found on burning tree.

Another type of tool-mark case occurred in 1943. Inside a burned area a large hollow beech tree was found burning. On its bark, about breast height, were marks apparently made by a blunt instrument with two kinds of edges, possibly a mattock. Footprints on a woods road, not far from the beach, led to a nearby house. The farmer living there said he and his boy had come over the road that day with a gun, mattock, and several peach tree transplants, but denied any knowledge of the fire or marks on the tree. The suspect willingly accompanied the investigators to the tree, where similar marks were made on the bark with his mattock. Sections were cut out and labeled for identification, and the farmer was told that they would be sent to the FBI Laboratory for comparison. A few days later, before a reply could be received from the laboratory, he called at the ranger's office and confessed that his son had pounded on the tree to chase out a squirrel, failed, and set it afire as a last resort.

A thorough search will usually reveal some clue. About dark, a towerman discovered a fire a few miles from his lookout, along a dead-end road. The fire crew arrived so promptly that whoever had caused the fire did not have time to get back out of the dead-end road. Fresh tire tracks led to an isolated spot in the woods where a car was hidden. Cached nearby were 800 pounds of sugar and 100 pounds of bran meal. Inquiry in a circuit clerk's office, 75 miles away, showed that the car had been registered in a fictitious name. This information and evidence found in the woods were turned over to the Alcohol Tax Unit agents, who later discovered a large still in the burned areas and made some arrests. The fire case was filed away, and the suspects were prosecuted for violation of the liquor laws.

A Lock of Singed Hair

A very unusual determination of responsibility was made after a fire on the Red River district in 1942. An alert ranger, searching carefully, found a lock of singed hair caught in the root of a stump. Horse tracks nearby led to a farmhouse, where a horse that made similar tracks was found. The owner admitted riding through the area, but denied causing the fire. The ranger obtained a lock of the suspect's hair. Both locks were sent to the FBI Laboratory, which replied that they were similar in every major respect. Confronted with this evidence, the suspect admitted he'd been drinking and had fallen off his horse, which ran home. He had lighted a fire to warm himself and when it scorched him, jumped up, bumped his head on the stump, losing some hair, and left without extinguishing the blaze. He paid a fine in the county court.

Ballistics

The science of ballistics is of frequent use to forest-fire investigators. Many fires are caused by hunters, from campfires, cigarettes, or in smoking game out of holes or trees. Often the hunter fires his gun and discards the exploded cartridge case. Every firing pin makes a distinctive mark on the cartridge.

In a burned area in Laurel County, an exploded shotgun shell was found near a tree that appeared to have sheltered wildlife of some kind. A "twist stick," used for poking into a tree hollow, lay nearby, and burned leaves in the cavity indicated that a fire had been used to smoke out game. Inquiry showed that several persons were seen in the vicinity the day of the fire. Examination of guns narrowed the suspects to the owner of a shotgun of the same gage as the shell found in the burned area. Permission was obtained to fire the gun in his presence.

Shells from this gun, along with the exploded cartridge case picked up at the fire, were sent to the FBI Laboratory. It replied that all the shells were fired from the same gun. This definitely placed the suspect in the burned area. Confronted with this evidence, he said he had been through the region several days before the fire and had shot at a rabbit. He showed the investigator a place outside the burn, where the alleged shot at a rabbit took place, but no exploded shell could be found there. Two persons, however, were located who had discovered the exploded shell soon after the blaze had started, when the odor of burned powder, they said, was so strong that not much time could have elapsed since it was fired. The case was brought to trial, but was lost because of certain technicalities.

Cigarette Packets

A simpler case followed a fire in Rowan County in 1943. Local farmers saw a blaze start about a minute after a stranger passed on horseback. A little girl saw the rider throw down a paper near the point at which an investigator found a "Kold" cigarette packet and a partly burned match. By means of various other clues, the stranger, a salesman who had traveled on horseback to visit a rural customer, was traced to his residence in a city 75 miles away. He admitted smoking "Kolds," but knew nothing of the fire. He readily agreed to settle the case, however, by pleading guilty before a United States commissioner.

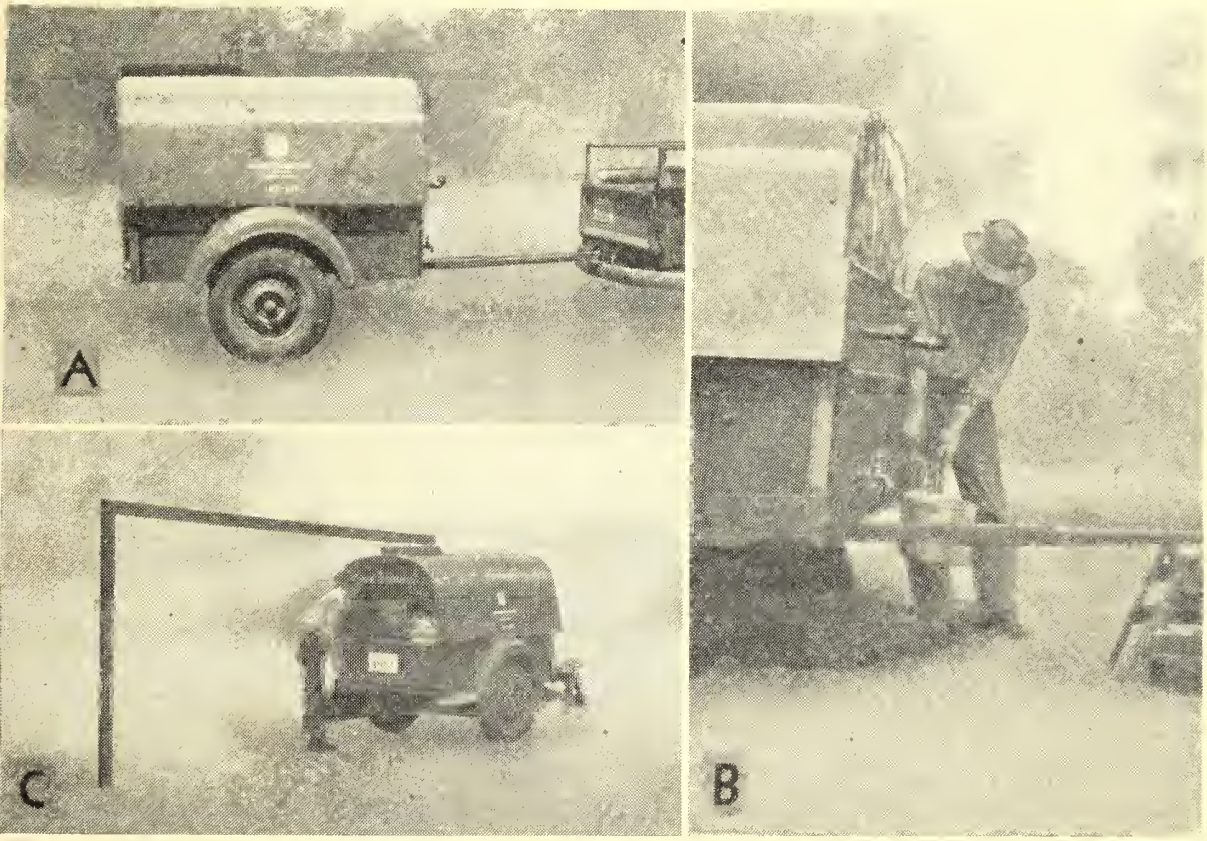
Conclusion

Our experience in tracking down woods burners has shown that the investigator need not be an FBI agent, a superman, or a trained scientist to attain the results described. He must, however, have sufficient training or experience to know what clues to look for, how to protect and preserve evidence, what significance the clues have, and where to secure expert opinion about them. With experience and a few pieces of inexpensive equipment, an investigator can often solve cases himself, without the help of experts. He must arrive on the scene before the clues are obliterated or get cold. And he must have persistence and the will to carry on in spite of obstacles.

FLORIDA CAMP TRAILER

Division of Fire Control, Southern Region, U. S. Forest Service

Mobility is a prime essential in all Coastal Plain fire fighting. Fires spread rapidly and in order to maintain a strategic position, it is frequently necessary to move the fire camp. For this purpose a mobile 25-man unit has been developed by the Florida national forests. Built as a two-wheel weatherproofed trailer, the unit is hauled behind pick-ups or larger sized trucks. This lay-out, which serves as a traveling kitchen, can be moved up to or on the fire line, a meal served, and then carried to a selected point for future use, with a minimum of moving time.



A: Side view of Florida camp trailer. Note the 2 x 4 on top, used as a rest for one end of a ridge pole. *B:* Front view of trailer and water-tank inlets and outlets. A sawhorse is used to keep trailer tongue level. *C:* Trailer set up on sawhorse with ridge pole and center post in place in preparation for making camp. Vertical peg in 2 x 4 secures ridge pole.

The camp trailer unit is the outgrowth of several years of experience in Coastal Plain fire fighting, and its value has been proved by successful use. It can be hauled over any woods road that a pick-up can travel. It is always kept at the central fire cache, in a ready-to-go condition.

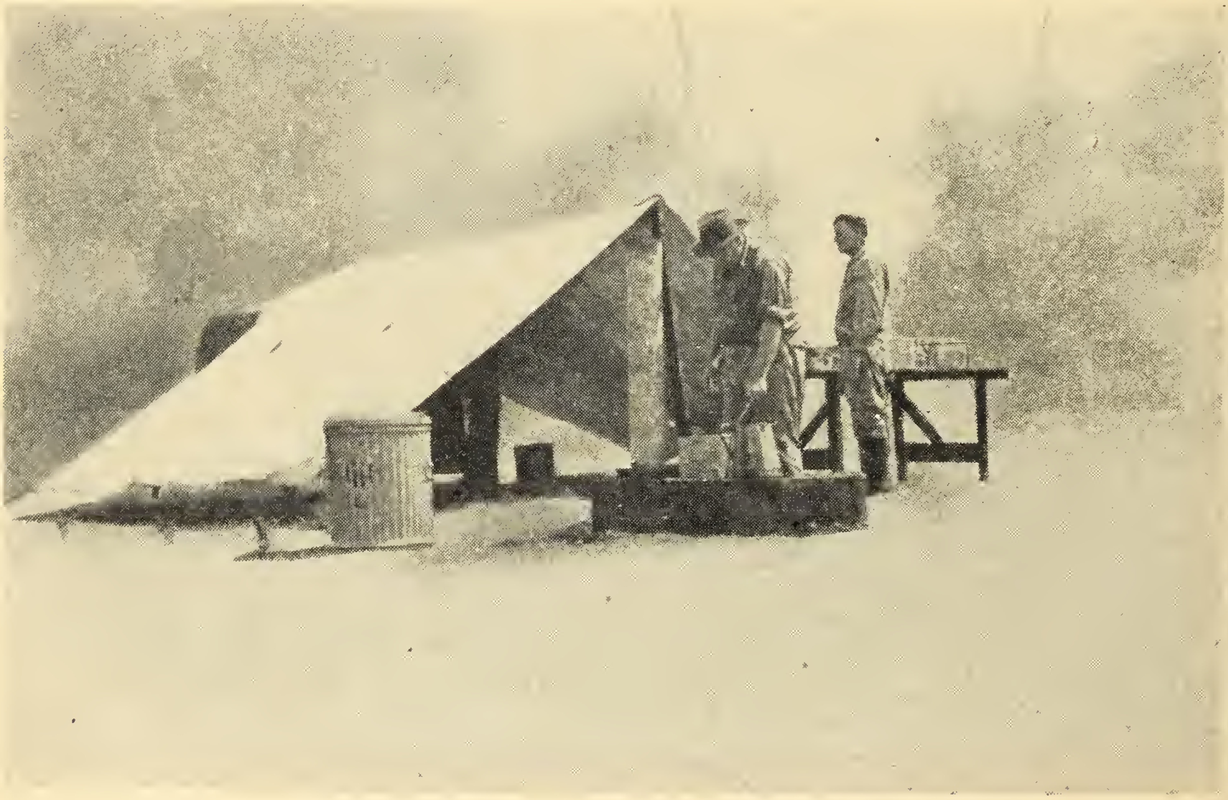
The trailer is roofed over with galvanized sheet metal and is weatherproof. The contents are secured behind a removable end gate.

A 25-man cooking outfit and forest-built stove are standard for the outfit. Food is kept in a special food box in sufficient quantities to furnish three hot meals for 25 men in addition to Army C or K rations.

A 30-gallon iron garbage can is used to heat large quantities of water over a grate or pit fire. A folding table and center post and ridge pole are regular parts of the equipment and fit inside the unit. A 10-gallon water tank, built into the trailer, is equipped with two ¾-inch water faucets and an inlet extending outside the body of the trailer at the front end.

When the tarpaulin is stretched into place over the ridge pole, a small but satisfactory shelter is provided. The trailer itself can be used as a storeroom.

Several national forests have developed similar mobile camp units with minor variations. In one instance, a small Delco light plant was built into one end of the trailer with an extension cord of sufficient length to light up the shelter, storeroom, kitchen, and immediate camp area. Such an arrangement has proven very satisfactory, as the ranger district where this trailer is used has over 100 man-caused fires per year, including many night fires.



Camp being set up, with trailer supporting ridge pole at one end.

○

Volume 7 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Address Division of Fire Control
Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1946

Contents

Page

The beetle tractor 1
North Pacific Region, U. S. Forest Service

The fire fly project 4
Neal M. Rahm

Airplane delivery of hot meals 8
Ralph S. Space

Coated binoculars 10

The broom-rake for line construction 11
Perle Lewis

Testing Army equipment for forest fire control use 12
George A. MacDonald

Fire prevention plans 16
A. R. Cochran

A smoke jumper crew at work 18
P. A. Thompson

Coski bed roller 20
Glenn Thompson

A preliminary survey of factors of visibility on small smokes in aerial detection 22
William G. Morris

Inventory of state fire control equipment 25

McLeod tool developments 26
Lloyd A. Qualls

Sheath for brush hooks 29
Henry Sipe

Holder for dehandling axes 30
Lloyd A. Qualls

North Carolina flame thrower 31
M. M. Carstarphen

Canvas gravity intake 33
Curtis E. Price

A live hose reel for Panama Pump outfit 35
M. S. Smothers

Power chain saw carriage 36
John W. Parker

The Florida drip torch 39
John W. Squires

Fighting fire with fog 41
J. W. West and Lowell J. Farmer

New ax sheath 45
V. C. Hallin

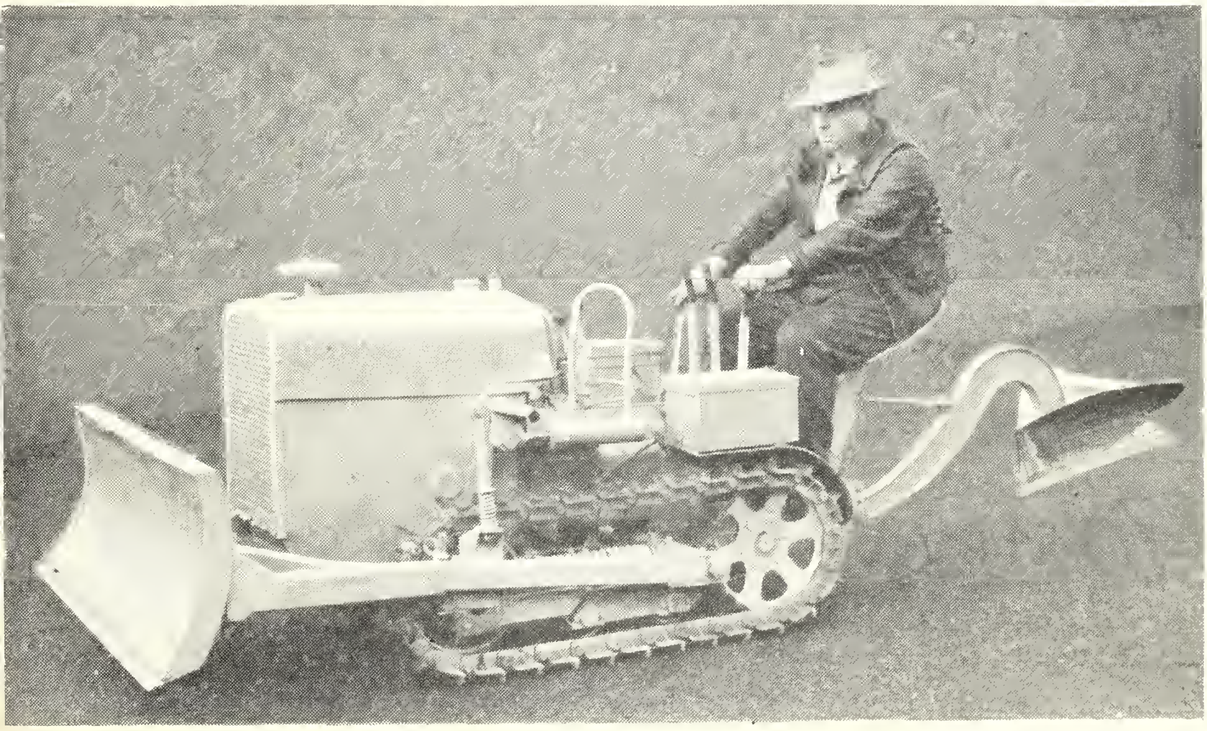
THE BEETLE TRACTOR

North Pacific Region—U. S. Forest Service

In various regions, during the past 10 or 15 years, there have been sporadic plans and trials aimed at machine maintenance of trails. On several forests in Region 6, small conventional tractors have been used to build or maintain "tractor trails." In general these turned out to be wider and more expensive both to build and maintain than the required service justified, and created drainage problems out of line with trail standards and costs.

In 1940, the Region 6 Trail Tractor was first used on heavy trail construction on the Siskiyou. It produced an excellent trail of satisfactory standard through difficult terrain at reasonable cost. The war interrupted progress on this network but work will be resumed in 1946 using the Clarkair military model developed by the Army from the original R–6 machine. Conclusions drawn from this project are that the 4,300-pound Clarkair is fully satisfactory for trail construction but larger and heavier than required for maintenance or for betterment and rehabilitation of existing trails.

As a result of experience with the 4,300-pound tractor, it was thought advisable to go to a still lighter machine for trail maintenance and betterment. In 1944 the equipment laboratory was requested to design a rugged, heavy duty unit not over 27 inches in



Wide gage beetle tractor with Wescoatt plow.

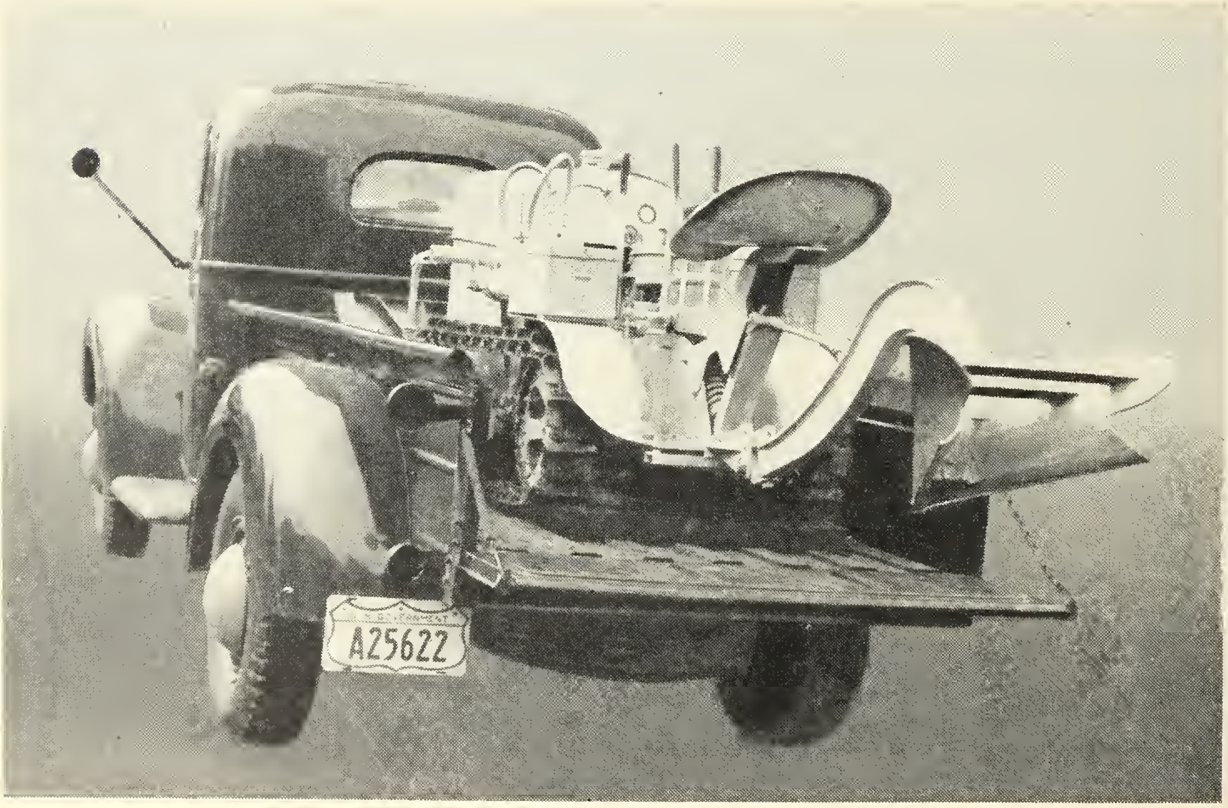
tread width, 84 inches long, with full hydraulic bulldozer, ample power, and light enough to be hauled in a pick-up. It was specified that basic tractor design should be followed insofar as practicable and commercial assemblies utilized to simplify parts procurement and repairs.

The equipment laboratory proceeded in line with the above general specifications. Design of the tractor was completed in December 1944, and plans turned over to the Portland departmental shop for fabrication. The pilot unit was finished in June, 1945. In order to differentiate it from other small machines it was christened the "Trail Beetle," which seems reasonably appropriate in view of its size and general appearance.

Beetle No. 1 was started out on the Clackamas River district of the Mount Hood. Work included removal of slough, windfalls, rocks and roots, widening narrow spots, rebuilding switchbacks to 6-foot radius, removal of puncheon and turnpiking wet spots, replacing bridges with fills, and other miscellaneous work ordinarily included in annual trail maintenance. During the course of the tests more than 20 miles of old trails were worked over and the machine was not "eased along." On the contrary, to determine weaknesses of design it was frequently put into situations beyond its capacity. Practically none developed. Results on trail rehabilitation were, in general, excellent.

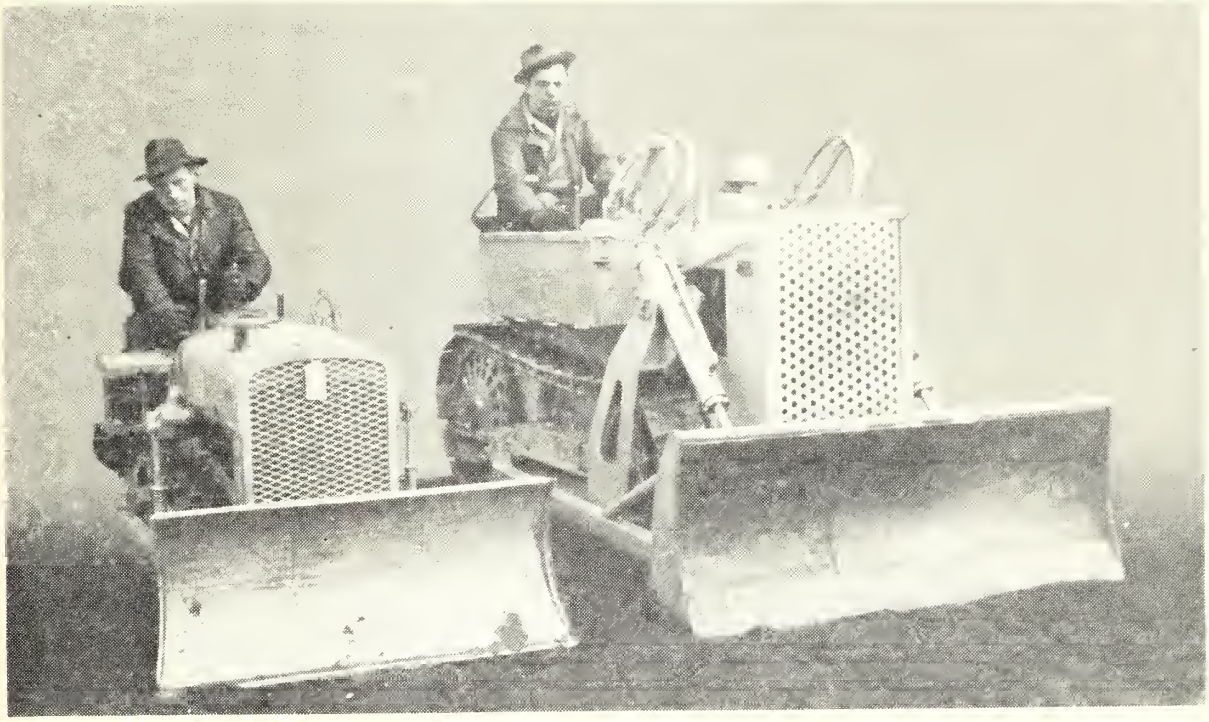
Plans are now under way for procurement from commercial sources of the beetle tractor with spare parts and it is hoped they will be available for the 1946 season.

This machine is primarily a trail worker but its small size and light weight offer fire-control possibilities in initial attack, and supplementing hand work until larger tractors can be delivered to the fire.



Wide gage beetle tractor loaded in pick-up.

Two narrow gage (27½-inch) beetle tractors are now available for use. A third, wide gage (32¾-inch) machine is undergoing tests for fire line construction. It now is equipped with a small Wescoatt plow. A disk plow will also be built and tried out behind it. In addition, it is planned to design a rotor attachment for trial use with this tractor.



Comparative size of the 1,800-pound 27½-inch gage trail beetle and 4,300-pound Clarkair.

Specification—Beetle Tractor

	Narrow gage (trail use)	*Wide gage (fire use)*
Weight, without bulldozer .... pounds..	1, 500	1, 530
Weight, with bulldozer .... do....	1, 800	1, 850
Over-all width on tracks .... inches..	27½	32¾
Over-all track length .... do....	51	51
Length of track on ground .... do....	36	36
Width of track plates .... do....	5¼	5¼
Width of bulldozer blade, straight .... do....	43½	50½
Width of bulldozer blade, angled .... do....	37	45

Over-all length with bulldozer, exclusive of seat overhang	82 inches.
Seat overhang	22 inches.
Motor, make	1 CK Waukesha, gas.
Motor, horsepower	12–14 b. hp.
Drawbar	1,600 pounds—10 hp.
Speeds, m. p. h.:	
Forward:	
First gear	1. 69
Second gear	2. 68
Third gear	4. 91
Reverse:	
First gear	2. 19
Second gear	3. 41
Third gear	5. 60
Average gasoline consumption, per hour	¾ to 1 gallon.

THE FIRE FLY PROJECT

Neal M. Rahm

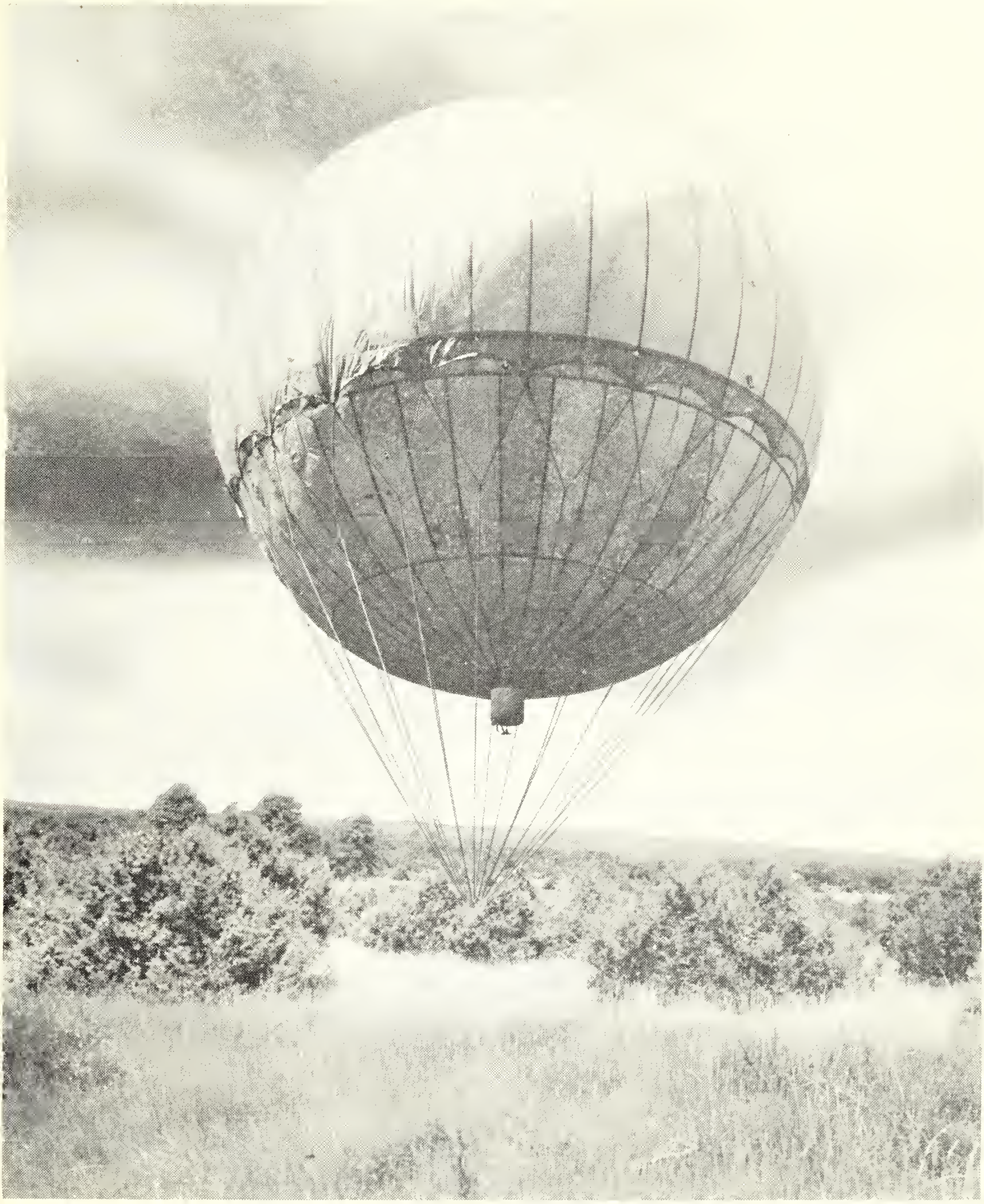
U. S. Forest Service, Liaison Officer, IV Air Force Headquarters

During the winter of 1944–45, forest supervisors and rangers in the western Regions were startled and concerned upon discovering they were actually under bombardment by enemy incendiary missiles and antipersonnel bombs. Free sailing, unmanned, paper balloons carried the bomb load which consisted of five cannisters filled with thermite and one large finned bomb containing shrapnel or three "fire pots."

District Ranger Raymond L. Beals and several inhabitants of Hayfork, a mountain town in northern California, narrowly escaped serious injury or death when the hydrogen-filled envelope of one such balloon exploded while landing in a tree. The recovered parts of this balloon and a complete unit discovered at about the same time by Supervisor Melvin E. Barron of the Modoc Forest were of vital interest to Army Intelligence. From these balloons and others recovered over a dozen western States, accurate information was rapidly assembled. They were being launched from Japan proper. Crossing the Pacific on wind currents at stratospheric levels, they reached the west coast in 80 to 120 hours. Most of the 298 recovered landed on the west coast, including Alaska, Canada, and Mexico, while a few went as far east as Michigan. An automatic device, controlled by aneroid barometers, dropped ballast and bombs.

The two objectives of the Army were rigid censorship to prevent the Japanese from learning if or how the attacks were functioning and destruction of balloons before the payloads were dropped. Censorship was remarkably successful. Leaks occurred late in the season, only when a woman and five children were killed in Oregon, and when an antipersonnel bomb exploded in an abandoned rock quarry near Santa Barbara. The Japanese, however, secured very meager information. They soon regarded the project as unsuccessful and, by April 20, 1945, abandoned the balloon attacks.

In the meantime, Federal and State agencies developed a system of detection and alerts which worked moderately well. Army air bases were kept sharp by numerous false reports. When the planet Venus became visible during daylight hours she was the target of 18 separate sorties in a single day. Experienced combat pilots claimed the balloons were difficult targets and could outfly a P–38. Near the Mexican border two Marine pilots and a salvage crew were dispatched to bring down and recover a balloon. At the first pass the pilots tried to place a short burst in certain apparatus to make the mechanism ineffective before "fanning" the envelope down with the "prop wash."



Japanese paper balloon.

They succeeded only in knocking off a few ballast sacks of sand which let the balloon rise to stratospheric levels. It was finally overtaken at an elevation of 40,000 feet where a brief burst and a blinding flash completed destruction. The explosion was so severe that the salvage party was unable to recover a single fragment.

Forest Service and other Federal and State agencies were gravely concerned. With the fire season but a few months ahead, the potentialities of the continued use of the incendiary missiles plus the possibilities of phosphorus leaflets warranted alarm. Never in the history of the Forest Service had there been such a dearth of men physically qualified to fight fire. The Washington office was requested to secure military assistance, without which the suppression problem appeared formidable. The Army was agreeable and designed a plan to provide assistance to civil agencies to combat forest fires started either by balloons or other causes. The Forest Service was designated to represent all fire protection agencies in the formulation of plans and operation of the project. Frank J. Jefferson, Assistant Regional Forester in R–5 was assigned the job of coordinator.

The Forest Service, together with the Fourth Air Force, Western Defense Command, and the Ninth Service Command devised a joint air and ground assistance plan. It was called the Fire Fly Project. It provided for troops specially trained and equipped to suppress fires. It further provided for air assistance in two forms: Reconnaissance planes and personnel to detect fires; and transport planes to carry paratroops to remote, inaccessible fires, supplies to fire fighters in such areas, and ground troops and Forest Service overhead where such transportation saved time. By May 19 the 3171st Eng. Fire Fighting Battalion (Prov.) consisting of 10 companies and 2,700 troops was organized. The 555th Inf. Paratroop Battalion consisting of 300 men was ordered for duty—200 stationed at Pendleton, Oregon, and a detachment of 100 at Chico, Calif. The First Troop Carrier Command with 7 C–47 planes was assigned the job of transporting personnel and cargo. The 161st Liaison Squadron furnished 32 L–5 and C–64 type planes and pilots for fire detection patrol flights and scouting activities.

Shortly after this activation, the State Foresters group, the National Park Service, and the United States Forest Service searched their personnel for the best training talent available. These men were thrown into one of the most intensive training tasks ever confronting fire protection agencies. The job of training 300 paratroopers, as well as 2,700 ground troops, was a real challenge. The paratroopers were given essentially the same training as the ground troops, to which was added a course in "smoke jumping"—one similar to that given regular Forest Service crews. The principal difficulty was weaning them away from Army methods which were not always adapted to our conditions. The Army used smaller chutes, dropping men rapidly from relatively low elevations and usually on flat terrain. The Derry chute developed by the Forest Service was larger, dropped more slowly, and could be guided by ropes attached to slots in the canopy. Up-drafts over rough terrain frequently held the chutes stationary in the air, or in some cases caused them to go up instead of down. This had an unnerving effect upon the colored paratroopers. In a few instances the men attempted to climb the shroud lines to determine what was holding them up.

By early July, troops had been trained and moved to their assigned camps in N. F. Regions 1, 5, 6, and 4. General areas were determined by the degree of existing potential fire hazard, and specific locations were, with one exception, at air bases of the Fourth Air Force or at camps adjacent to bases. These were picked to facilitate air movement of troops. Two fire control sections, one at Silver Lake, Wash., and the other at San Francisco, Calif., were established and representatives from the Forest Service, Ninth Service Command, First Troop Carrier Command, 161st Liaison Squadron, and the Fourth Air Force were on deck, prepared to coordinate the efforts of their commands.

Shortly after the first of July, severe lightning storms opened the fire season with a bang. A fire situation developed in Region 5 and Region 6 which at times exhausted all Fire Fly personnel in these regions. Troops were flown from Camp White, Pendleton, Spokane, and Chico to fires in Oregon, Washington, and California. All units received their baptism by fire and functioned well. During the first 2 weeks of July, the Troop Carrier Command carried 70,000 pounds of cargo and 681 men. On the Klamath Forest in California, 800 men were subsisted by aircraft; 17,000 pounds of food and equipment being parachuted to them during a single day. The disastrous Wilson River fire in the Tillamook area in Oregon started at this time and was not controlled until the early part of September. During the latter part of July, all Fire Fly personnel were withdrawn from this fire and a regiment of Army engineers took over suppression work on a project basis.

In August, two bad situations developed in California, again caused by lightning storms. These same storms aggravated existing serious fire problems in Region 6. Regions 1 and 4 also exhausted all their units at one time during the month. The fire season terminated, or was sharply reduced in Regions 1, 4, and 6 during the early part of September, but because of high winds and low humidities, serious suppression problems continued throughout September and into October in Region 5.

An innovation to our general use of parachute attacks was jumps in force. In one instance 100 troopers and full equipment were dropped as a follow-up on a 300-acre fire in the Chelan National Forest, Wash., where the initial attack by 10 Forest Service smoke jumpers failed to hold the fire. For the first time in the history of Region 6, a large fire in this inaccessible location was controlled within the first burning period. Another mass jump by 50 men was made in the rough Mount Baker area in this same region, but for the most part 6 to 12 men were jumped on single fires.

Total military effort for the four western regions amounted to 147,562 man-days of fire fighting. They suppressed or assisted in the suppression of 282 fires. The paratroopers contributed 4,012 man-days of this total and worked on 28 fires. For their share of the effort, the troop carriers dropped 178,974 pounds of cargo and transported 2,313 personnel. The Liaison Squadron reported 145 fires, 5 balloon incidents, and flew 3,905 hours on 1,978 separate sorties.

The cooperation and coordination required to make the organization function efficiently was remarkably good. The fire record of 1945 reflects the success of the organization. The Fire Fly project, with its joint control by several branches of the Army and the Forest Service, all working together toward a common objective, will remain forever unique in Forest Service history.

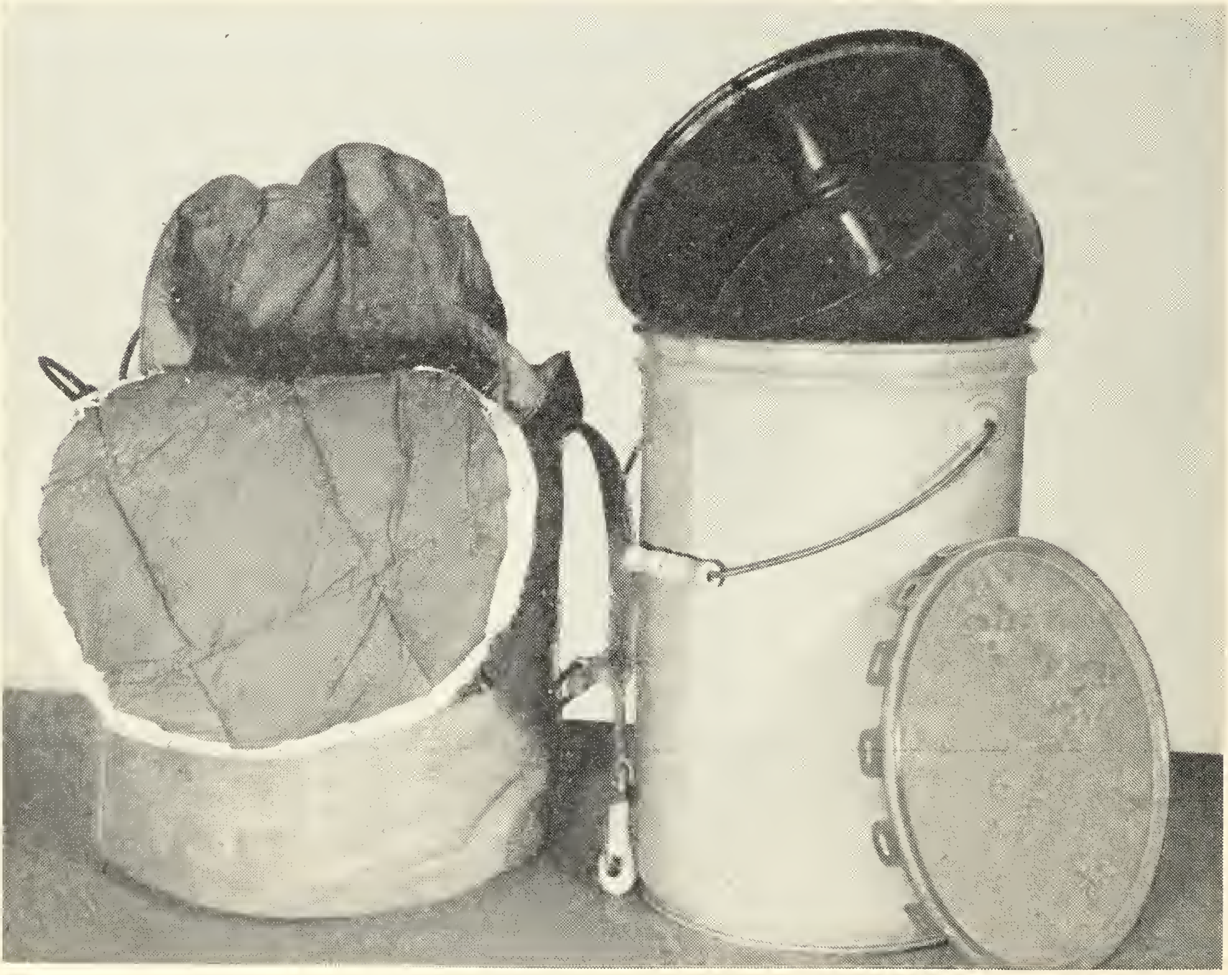
AIRPLANE DELIVERY OF HOT MEALS

Ralph S. Space

Northern Region, U. S. Forest Service

How many times have cooking outfits, complete with rations, cooks, and flunkies, been moved into fire camps only to serve one or two meals? When the costs of setting up a kitchen, packing in and out, cleaning up and repacking the mess outfit, and cook and flunky wages, etc., are added up, the cost per meal is enormous. In addition to these costs, time and energy have been lost hiking from the fire line to a camp for meals. Rarely is it possible to establish a camp right on the fire line. More often anywhere from 30 minutes to an hour or more have been lost hiking to and from work.

To cut losses in time and energy, in particular, and in some cases to feed fire crews more economically, Region 1 designed containers for delivery of hot food by plane and parachute. The method included the use of new inexpensive 5-gallon paint cans, enclosed in kapok cases,



Hot food container with kapok bag for insulation.

much like those in which ice cream is packed, except that each of these containers is provided with two or three compartments as needed instead of one. Food packed by this method has been kept hot 4 hours, which is ample time to fly it from Missoula to any point in the region. The over-all cost of each container unit (which includes paper dishes, paint cans, and protecting bags made from condemned kapok beds) is about $5. The unit can be abandoned in the field if the situation warrants.

Almost any type of meal can be furnished and menus are varied. For instance, a dinner may include meat—fried, roasted, or in a stew—mashed potatoes, peas, and gravy. If stew is furnished, gravy is omitted. Such a meal requires two containers of two compartments each. Hot coffee or a cold drink is furnished in the third container, which is equipped with a flexible spout. The food is prepared in a local restaurant and packed in the containers.

Hot coffee container with kapok bag for insulation.

The saving in time and energy with small crews has indicated the possibility of delivering food in such containers to crews on large fires. However, certain problems, such as how to drop the containers safely through the heavy smoke blanket that hangs over large fires each morning until about 10 a. m., will have to be worked out. For small crews, though, the economy of delivering hot meals by parachute is now well established.

In 1940 an old fire boss was sent with 25 men to control a fire on top of a fairly high peak. They started early in the morning, backpacking their tools and 1 day's rations. It was a nip-and-tuck battle and around 5 o'clock in the afternoon the fire boss radioed that he had the fire under control but did not dare leave it for the night. He also reported that they had only enough food for one meal, breakfast, and very little water. Could it be arranged to send some food by parachute so he could stay overnight and mop up the fire early the next day?

"Sure," the dispatcher replied; "what do you want?"

"Well, I am not particular. Just something to eat and drink."

"How about roast beef, mashed potatoes, gravy, peas, and coffee?"

"Huh? Oh, yeah! Sure; and you might send some ice cream."

Within 2 hours he was greatly surprised to get it all, including the ice cream.

Coated Binoculars.—The first report to reach Region 3 on the use of "coated" binoculars came from District Ranger Dean M. Earl of the Apache National Forest. Although he knew there had been quite a little discussion on the coating of optical instruments, he had seen no accounts of tests made under forest conditions. So when he received a pair of B & L 7 x 50 binoculars which had just been coated, he made a few comparisons.

In his report, Ranger Earl states that the greatest single improvement lies in their use in looking toward the sun. As long as the sun does not actually enter the image, there is almost no glare. Objects nearly in line with the sun, that are only a blur to the unaided eye, stand out sharply through these coated optics. He believes that this improvement alone is well worth the cost of coating. He says that although the coating does not screen out haze, the increase in sharpness of the image is such that the effect of haze is greatly reduced. He also says the coating increases color definition, increased depth perception makes it possible to determine smoke location more accurately, and increased light transmission makes it possible to see into shadows that you could not penetrate with uncoated optics.

Ranger Earl believes much is to be gained in fire detection by the use of properly coated binoculars in lookout towers.

THE BROOM-RAKE FOR LINE CONSTRUCTION

PERLE LEWIS

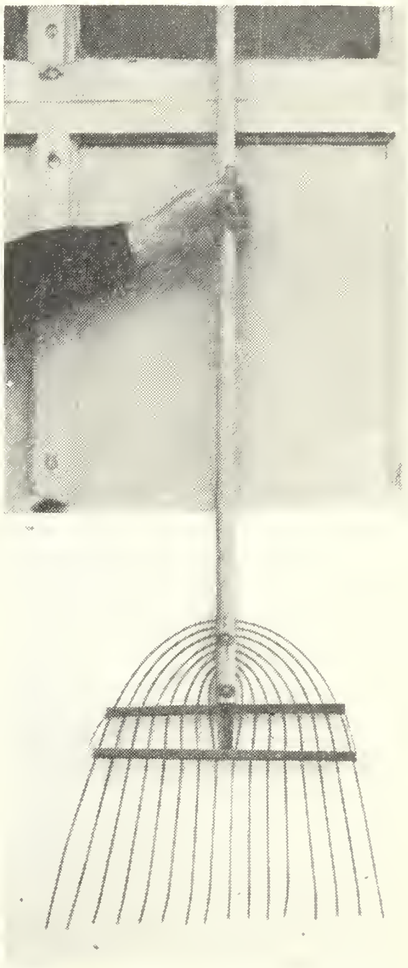
Forester, Clark National Forest,
U. S. Forest Service

Every known style of broom-rake on the market has been tried on the Clark National Forest for line construction, but only one has stood up over the years under rough use. After 9 years' use on more than 9,000 fires, the simple tool illustrated on this page is still preferred over the heavier Kortick and Council tools which it replaced for fire-line raking in leaf-type fuels. Several other forests in this region also prefer this broom-rake.

Advantages

Advantages of the broom-rake are:

1. The light weight makes it less tiring to use. The simple broomlike stroke requires no back bending, and the steel tines bend over and around stones and roots instead of hanging on or moving them.
2. The tool is more effective than other rakes because the long spring tines reach between or under rocks, roots, or logs and move the leaves, twigs, and small branches down to mineral soil.
3. Line construction with the broom-rake in leaf fuel averages 6.5 chains per man-hour as against about 4 chains with heavier rakes.
4. The broom stands rough use well, although it is not as sturdy as other raking tools. The average rake can be used to construct about 160 chains of line before becoming unserviceable. However, when the average cost of constructing 160 chains of line is considered—$18 with heavier tools against $10.80 with broom-rakes—the expenditure of the 40-cent rake is amply justified.



Broom-rake for fire-line construction used on Clark National Forest.

Defects

Two defects of the rake are being studied at present. One is the weak attachment of the handle to the rake; the other is the slipping of the tines from one side of the rake to the other.

The rake shown here is manufactured by the General Hardware Co., 3618 West Pierce Street, Milwaukee, Wis.

TESTING ARMY EQUIPMENT FOR FIRE CONTROL USE

George A. MacDonald

Washington Office, U. S. Forest Service

In the fall of 1944, a committee representing the Divisions of Fire Control and Engineering and the Branches of State and Private Forestry and Research inspected the many equipment items exhibited in the depot of the Quartermaster Board and selected seventeen as possibly suitable for fire control use. Samples of these seventeen items were sent to various regions for study and testing. Following is a brief description of each item and regional comments:

Packboard

A molded plywood frame, with laced canvas back piece, web straps, hooks and lash rope. Principal advantages are: good ventilation and load distribution, no protruding side members to chafe the wearer's back or hips, and very satisfactory lash hooks. A pack bag can be attached easily if desired. Moisture does not appear to affect the plywood. This packboard is considered well adapted to Forest Service work and superior to the well-known Trapper Nelson and other canvas-lined packboards.

Signaling Mirror

A 4″ x 5″ mirror of highest quality tempered glass. At the center is a window with a small red reflector, hinged at an angle to the mirror. The "red spot" produced by the reflector enables the user, looking through the window, to line up the mirror with the target so that the flash can be seen. Region 6 tested the mirror by signaling from one lookout to another, from a smokechaser to a lookout, and from the ground to aircraft. Considered so satisfactory that the region desires 1,000 mirrors if they can be obtained at small cost.

Smoke or Dust Goggles

Region 5 found these goggles quite satisfactory where smoke or dust was troublesome.

One-Quart Collapsible Canteen

Made of plastic-impregnated fabric, encased in a canvas bag. Has plastic neck and cap. Weighs 9 ounces. Region 5 tested it with the usual treatment to which canteens are subjected and found it durable.

When empty it flattens into a very small space and the neck and cap do not become bent, as frequently happens with metal canteens. The only disadvantages are that it cannot be filled by dipping it in a stream and the material gives a peculiar taste to water.

One-Burner Cooking Outfit

A nest of three aluminum kettles, the largest being 8 inches in diameter and 4½ inches deep, a frying pan, and a small gasoline pressure burner, with collapsible legs, which nests in the smallest kettle. The outfit is compact and weighs 3 pounds. Ranger Hugh Ritter, Region 6, used one of these outfits and found that the burner had to be pumped up every few minutes, with danger of tipping over, and that in frying the heat was not sufficiently diffused to the outside of the pan. He believes the outfit practicable for use where fuel is lacking or so wet that starting a fire is difficult.

One-Gallon Collapsible Water Bag

A gourd-shaped vinylite bag. To close the bag, the long neck is folded several times and secured with a plastic strap. The bag will hold air and makes a good pillow. This article, also, was tested by Ranger Hugh Ritter, Region 6, who reported it inconvenient to handle. It should be encased in a suitable canvas bag, with carrying strap. No information as to its durability is available.

Hand Smoke Signal

A distress signal, designated Mark 1, Model O, 1½ inches in diameter and 4 inches long. Weighs 8 ounces. Emits orange-colored smoke and burns 20 seconds. Region 6 tested it in open ponderosa pine and Douglas-fir timber, with a slight breeze blowing and excellent visibility from fire lookouts and ranger station. Results were as follows:

Distance:	*Period smoke visible (seconds)*
6 miles	15
19 miles	15
16 miles	25
20 miles (field glass used)	60
11.5 miles	120
4 miles	50

From all stations, smoke could be seen approximately 100 feet above the treetops. The smoke does not last long enough to serve as an effective signal by smokechasers, and unless the air is almost still it will not rise above the timber. Region 6 also tested other Army distress signals, obtained directly from the manufacturer, and will continue tests with these large signals in 1946, in an effort to obtain suitable signals for use as test smokes, for signaling by smokechasers, and to show the location of a spot for dropping supplies from an airplane when there is a layer of smoke.

Wool Sleeping Bag

Made of single wool blanket material. Weighs 3 pounds. Has parka top and 30-inch open-end zipper. Width near top is 27 inches, and at bottom 15 inches. The cover for the wool bag is made of waterproof material and weighs 2 pounds. It has a 34-inch opening, with grommets for lacing and also snap fasteners. Region 4 considers this bag not warm enough for the higher elevations, even in summer. Region 6 says it would be a reasonably good bed for a fire fighter in warm weather, but the open-end zipper would cause trouble and the grommets and snap fasteners on the cover are not as satisfactory as an ordinary zipper.

Mountain Sleeping Bag

Regions 1, 4, and 6 received two down bags, one weighing 4 pounds 8 ounces and the other 5 pounds 6 ounces. Both have parka tops. The lighter bag is 30 inches wide near top and 15 inches wide at bottom, with a 27-inch closed-end zipper. It fits the waterproof cover described under "Wool Sleeping Bag." The heavier bag is larger and may be intended for use outside the lighter one. It has a full-length zipper.

Region 1 reported that it believes the lighter bag is equivalent to the goosedown bag purchased by the Forest Service, but will not replace the kapok bag, as it is so thin that a bough mattress is needed.

Region 4 used the lighter bag with the wool bag inside it and the waterproof cover outside. To keep warm two thickness of Army blanket and a tarp were needed. They tested the heavier bag in a metropolitan bag, with air mattresses, inside a tent. Double wool blankets were used inside the heavier bag, which was about as warm as a 4-pound wool batt. They do not consider these bags suitable for Forest Service use.

Region 6 says the casing of neither bag is down-proof and the parka tops are unsatisfactory. The 6-pound goosedown bag, as purchased in Region 6, is better. They believe, however, that with some changes these Army bags, with a waterproof cover for each size, would serve as fire fighters' beds and it might be desirable to acquire them if the price was low. One bag inside the other is considered too warm in Region 6.

Field Range, M–1937

This item was tested in Region 6 and found to be unsatisfactory for fire-camp use. Its weight of 200 pounds makes it difficult to transport and the general arrangement of cooking features is not most practical.

Gasoline Cook Outfit

This outfit for small detachments was tried out in Regions 1 and 4. The pots, pans, kettles, etc. formed the stove lids and all openings must be covered to get circulation of the heat. This was inconvenient when cooking for a small group, because the unused openings had to be covered with containers full of water. Both Regions considered the outfit not suited for forest camp use.

Tent Stove, M–1941

A round, pot-type stove of cast iron, 18 inches in diameter and 17 inches high. Regions 1 and 6 concluded that with wood available the Sibley stove now used by the Forest Service is superior.

Officers' Mess Outfit, M–1941

This 8-man outfit was tried in Regions 4, 5, and 6. The case and utensils weigh 50 pounds. Region 4 reported the unit satisfactory when 6 or more men use it. Region 5 considered the outfit unsatisfactory because the enameled ware was easily chipped and constituted unnecessary weight. All agreed that the present Forest Service aluminum mess outfits are superior.

Army Company Field Desk

This desk is a metal-bound fiber case with compartments. One side is hinged to form a writing desk. Regions 5 and 6 concluded that the company boss box we now use meets our fire-camp needs better.

Immersion Water Heater

This heater, bootlike in shape and designed to burn gasoline, was tried in Regions 5 and 6. Both Regions report the unit inferior to other units used to heat water in fire camps, such as the Portable Water Heater described in FIRE CONTROL NOTES, April, 1946.

Food Containers

Regions 1 and 6 tested Army rectangular and cylindrical food containers for delivery of hot food to field crews. They concluded that insulated containers now in use on the national forests are superior and less costly. See description in FIRE CONTROL NOTES, April, 1946.

Army Type Ice Creepers

These creepers were tried in Region 1 and 6 as a substitute for calked shoes. The ice creeper is an expanding metal clamp studded with seven spikes. It is attached to the shoe by webbed straps at the toe, instep, and ankle. The Regions found them burdensome to the feet and generally unsatisfactory.

FIRE PREVENTION PLANS

A. R. Cochran

Forest Supervisor, Jefferson National Forest, U. S. Forest Service

Fire prevention is one of the several ranger district activities that has many parts. These parts or jobs are like the pieces of a jigsaw puzzle. They don't make sense: all is confusion until they are put together in a plan. The relative position of any specific job is determined by the season and by the person who is responsible for it. When they are fitted together to make a plan, a picture of the whole fire prevention job on the district is obtained.

The plan gives the ranger a quick reference for current planning and shows who is responsible for what jobs at the time the jobs come up. The ranger carries his fire prevention plan in his master plan book. The supervisor finds the fire prevention plan an aid to inspection for quantity and quality of work because he has the whole picture before him and can inquire about any part to determine its status.

The fire prevention plan is produced under the Regional Fire Control Standard which requires on each district a study of the man-caused fires over the past 2 years and the preparation of specific action plans for preventing such fires. The plan consists of two parts:

A. Conclusions reached from study of occurrence records and special situations affecting fire occurrence.

B. Tentative assignment to individuals of all prevention jobs with time and place for each.

Part A, and 1 month of part B of the Holston Ranger District fire prevention plan, fiscal year 1946, are given below as a sample:

Holston District Prevention Plan, Fiscal Year 1946

Part A.

Fire Problems:

Pine Mountain Areas	5 fires annually, range burning.
Poor Valley	4 fires annually, smokers and campfires.
Currin Valley	7 fires annually, debris burning.
Sprouts Creek	3 fires annually, incendiary—since 1940—all in a high hazard area.
Konnarock and White Top areas.	These areas have had range burning fires and debris burning fires for 10 years.
N. & W. Railroad	5 miles of right-of-way.

Part B.

(1) Prevention Jobs:

Month	Job	Dispatcher hours	Top guard hours	Ranger hours
Feb.	Distribute debris burner prevention letter:			
	Prepare letter for mimeographing			2
	Determine list of addresses	2	2	
	Mail	8		
	Post contact record	2		
	Make personal debris burner contacts—Konnarock area		8	4
	Make personal contacts with specific debris burners (average of 20 per year)	4	4	4
	Contact law enforcement officers: 1 trial justice, 1 State policeman, 2 county wardens, 1 FBI agent, 4 game wardens		3	3
	Contact railroad officials to see if R/W hazard has been reduced		4	
	Show vocafilms to 18 graded schools		18	
	Maintain No. 1 poster display at 9 schools		6	

(2) Special Projects:

Poor Valley.—Patrolman make intensive contacts with fishermen in April and hunters in November.

White Top.—Fred Weaver contact range land owners each spring (5 days required). He will also make a special effort to "trail" the notorious Doc. Osborne.

Sprouts Creek.—Lookout A Thweatt make personal fire prevention contacts 3 days prior to each fire season. This area is noted for incendiarism.

A "SMOKE JUMPER" CREW AT WORK

Condensed from Region Four Report, by P. A. Thompson, Chief Division of Fire Control, Washington Office, U. S. Forest Service

The following is a brief account of the experiences and accomplishments of the 36-man "smoke jumper" crew stationed at McCall, Idaho, last summer. It was abstracted from a more detailed official report prepared by Region 4 of the Forest Service. It gives a good picture of the present status and potential value of aerial methods in roadless country in terms of on-the-ground experience.

In 1945 Region 4 of the Forest Service maintained at McCall, Idaho, a 36-man "smoke jumper" unit. These 36 flying firemen were trained to parachute from airplanes to fires in the forested mountains in that section of the Northwest. The area in which they parachuted to fires includes parts of three National Forest Regions, seven National Forests, and a lot of private lands. The topography varies from the flat sagebrush plains of southern Idaho to the rugged peaks and ridges of the Seven Devils in western Idaho, the Wallowa Mountains in Oregon, and the southern Bitterroots in northern Idaho. There is no more rugged terrain in the United States. It varies in elevation above sea level from 600 or 700 feet in the bottom of the Snake River Canyon to 9,000- and 10,000-foot peaks in the forests.

The crew was ready for business on July 1. Lightning fires started on July 11 and the first 2 jumps were made on a fire in the Payette National Forest. The season ended on September 16 when the last 4 jumpers walked out from the Fritzer Creek fire on the same forest. Between these dates men jumped to fires every week. Sixteen fires were handled in one busy week! The 36 smoke jumpers made 231 fire jumps on 66 fires. Of these fires 46 were suppressed by 2 jumpers; 12 fires required from 3 to 5 jumpers; 5 fires required from 6 to 10 jumpers; 3 fires required from 11 to 29 jumpers.

On August 2, 21 jumpers from McCall and 8 borrowed jumpers from Missoula parachuted to the Acorn fire. On this day the burning index was 73, which is extremely high; and winds varied from 10 to 30 miles per hour. The report states, "it was on this fire that the ground winds reinflated cargo chutes after landing and dragged 125-pound cargoes up 100 percent slopes." Nevertheless this fire was promptly controlled at less than 100 acres.

On September 2 on the Fritzer Creek fire the burning index was 85 and winds from 15 to 25 miles per hour. Six men jumped the first evening. On September 3 the burning index was 92 with increased winds. Nineteen additional men were jumped in one sector. The report states, "they alone stopped this fire on a critical 1-mile flank that was sweeping into adjacent drainages. The saving over ground crews here was probably 1,000 acres. The 25 smoke jumpers handled the most difficult one-third of this fire at one-eighth the cost." On this day 31 of the 36 smoke jumpers were out on fires. Only 5 men were held on standby for call.

This was a busy crew. Between the first fire jump and the last fire jump there was a total elapsed time of 68 days. Sixty-eight (the number of days) times 36 (the number of men) equals 2,448—the total available man-days. The 36 jumpers spent 830 days on fires which is 34 percent of the total days. But this is not all—on those 830 days the men put in 5,025 overtime hours. This is an average of 6 hours overtime for every man-day worked. A good portion of this overtime was accumulated on Saturdays and Sundays. If the regular 8-hour days worked is added to the overtime worked we get 11,665 hours or an equivalent of 1,458 8-hour days. This means that for the 9-week fire season these 36 men *worked at fire suppression* the equivalent of 60 percent of the total man-days available, Saturdays and Sundays included.

The cost section of the report is of particular interest. For purposes of comparison, reports on fires which occurred in former years in fire weather, topography, and fuel conditions comparable to the 1945 fires were studied. A total of 33 comparable fires were found—the region describes conditions as "identical" with 33 of the 1945 fires. FF costs of the comparable fires suppressed by ground forces were $92,393 *more* than the cost of fighting the 1945 fires with smoke jumpers.

The total cost of the 1945 smoke jumper operation was $23,112. The men were C. O.'s so were not paid wages. A comparable crew will cost about $60,000 in 1946 at present wage scales. It should be worth the cost for, if it makes a record comparable to that of the 1945 crew, it should save at least twice $60,000 in FF and greatly reduce area burned.

No estimate is made of forest acres saved from burning in 1945 but the size class record of the 33 comparable fires with the 1945 fires follows:

	A	*B*	*C*	*D*	*E*
1945 Actual, smoke jumper-suppressed fires	23	7	2	0	1
1937–39 "Identical" ground force-suppressed fires	10	11	7	1	4

These figures are quite significant and considered with the cost records afford pretty convincing evidence that the aerial method of transporting men to fires in remote country is good business. If the manufacturers of helicopters will just hurry up and make available satisfactory aircraft of that type, the aerial method of "getting them small" can be extended to more millions of National Forest acres.

Approximately 220 hours flying was required to transport jumpers to fires and 40 hours for training jumps.

Twenty requests for jumpers could not be met because men were not available.

There were no lost-time accidents.

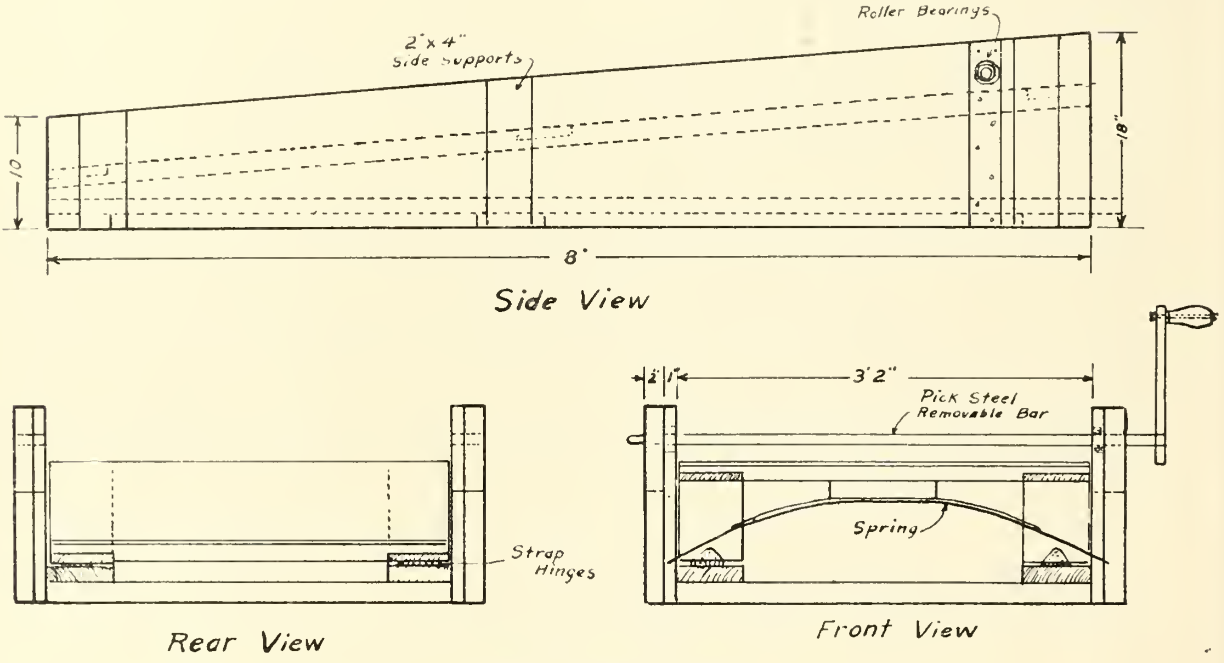
COSKI BED ROLLER

Glenn Thompson

Fire Control Staff Officer, Payette National Forest

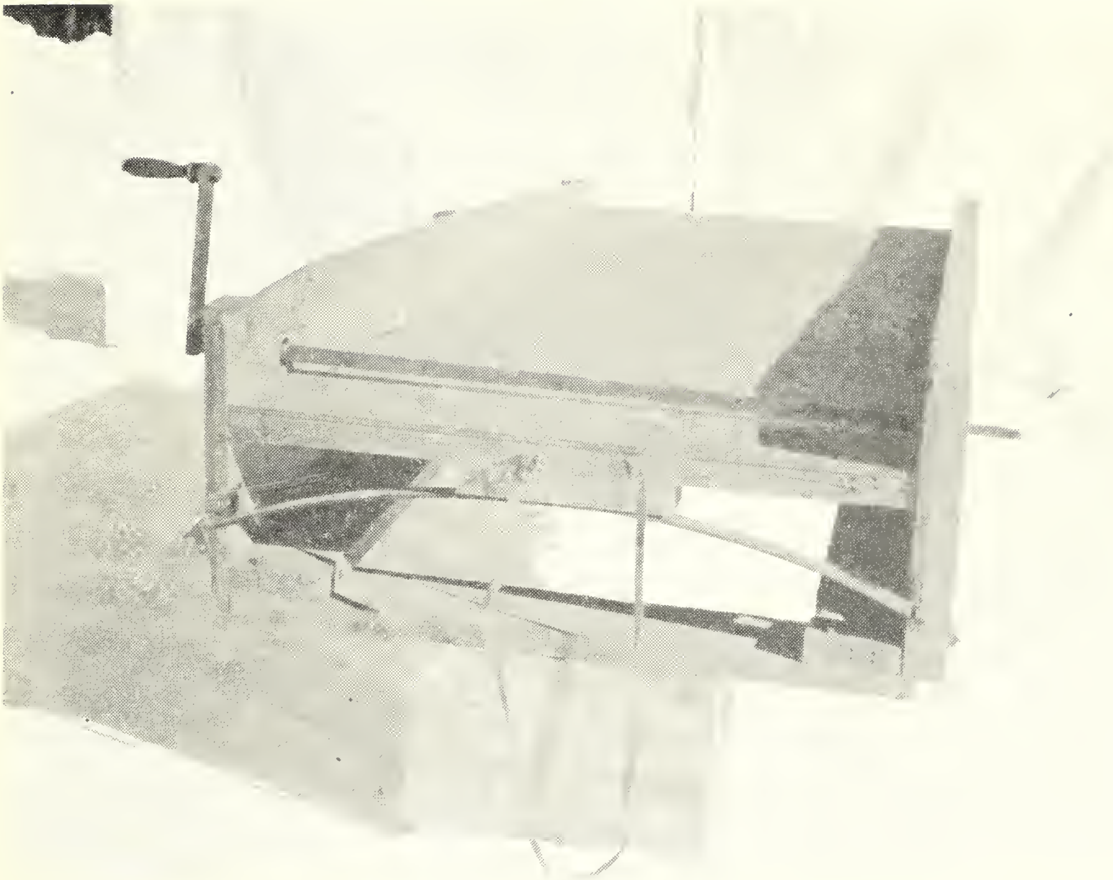
Large quantities of fire beds and bedding are cumbersome to handle and store. Hand rolling them after cleaning is a tedious, time-consuming job and in transportation, particularly by air, their bulk usually has exceeded space limits before load limits have been reached.

In 1938 when Thomas Coski, an experienced employee on the Payette National Forest, was confronted with the task of rolling 2,000 kapok fire beds for storage, he evolved the idea of a bed rolling machine which adapts the mechanical principles of friction and compression. Results were very satisfactory and the device has since resulted in great savings in time and storage space. The number of beds rolled has been increased from 10 by hand to 20 per man-hour by use of this machine. About a third more beds can now be stored in the same amount of space.



Coski Bed Roller

We use the machine for rolling all cotton, wool, and canvas materials as well as for kapok beds. The item to be rolled is spread on the platform and folded, if need be, into the desired length and width. One end of the item is then engaged around the square bar by hand and rotating is begun. The entire crankshaft assembly is pulled out after the completed roll is tied. Power rotation is now being adapted to the bed roller.



Upper end view of Coski Bed Roller with crank in place. Note position of compression spring which keeps bedding tight against roller and allows roll to increase in size.

Coski Bed Roller in use.

A PRELIMINARY SURVEY OF FACTORS OF VISIBILITY OF SMALL SMOKES IN AERIAL DETECTION[1]

William G. Morris

Pacific Northwest Forest and Range Experiment Station, Portland, Oregon

With the trial use of airplanes as the principal means of detecting forest fires on a large portion of the Chelan National Forest in Washington during 1945, numerous questions arose concerning the principles that should be followed to obtain the best detection with a given amount of flying. Factors of visibility of small smokes from lookout stations have been previously studied and reported. The results of these previous studies were demonstrated and tested in September 1945 on the Chelan National Forest to show how they apply to aerial detection of small smokes.

As indicated by these previous studies two of the important factors which apply to the visibility of small smokes from airplanes are brightness or color of the background and angle between the lines of sight from the observer to the smoke and from the observer to the sun. Visibility of white smoke in full sunlight against dark backgrounds decreases gradually as this angle increases. Against a mottled background visibility is about the same as against a dark background for angles from 0 to 70° from the sun but the visibility decreases rapidly as the angle increases beyond 70°; against a light background the visibility is less and the optimum angle from the sun is about 40°. From this optimum the visibility decreases rapidly as the angle increases.

On first thought it may seem contrary to experience that a smoke as indicated above is more visible when looking toward the sun than when looking away from it. A person usually thinks of visibility in terms of common objects such as ridges and trees, which are less visible when looking toward the sun. The opposite is true of smoke.

This greater visibility of smoke looking toward the sun applies only to smokes in full sunlight. For all practical purposes the safe visibility distances of smokes in shadows when looking toward the sun is zero. When looking away from the sun the visibility is better but is still considerably less than if the smoke were in sunlight instead of in shadow.

When looking away from the sun smokes can be seen farther on a cloudy day than on a clear day, especially if looking toward a light background. On a clear day, the visibility is greatest when looking toward the sun unless the smoke is in a shadow. On a cloudy day the visibility distance when looking away from the sun is the same as when looking toward the sun.

The greater visibility of smoke in sunlight on clear days would indicate that under such conditions a plane flying low would afford a better chance to see a small smoke than if it were flying high, because the angle between the lines of sight from the observer to the smoke and to the sun would be smaller. The facts concerning visibility of smokes on cloudy days would indicate that the plane could fly up or down either side of a drainage and have an equal chance to see a small smoke. On a clear day the side of the drainage from which the observer is looking most nearly toward the sun would afford the best chance of detection. In early morning or late afternoon, when there are shadows on the steep slopes, the chance of detecting a small smoke will be much less than during midday; thus, the patrol flights should be scheduled when there are no shadows on the hills. Broken clouds that cast deep shadows will also reduce the chance of detection.

---

[1] Condensed slightly from the full article, containing references, which may be obtained from the Pacific Northwest Forest and Range Experiment Station, U. S. Courthouse, Portland 5, Oreg.

Two series of tests were made. Test-smoke bombs or smoke candles were burned under various conditions of haze, position of the sun, and background, and their visibility was recorded from different positions and elevations by an observor in an airplane.

In the first series of tests, smoke candles were ignited one after another on the airport field to provide a continuous flow of smoke while the observation plane circling above gradually increased the radius of its circle to 5 miles from the airport and at the same time climbed to an elevation 14,000 feet above the airport. The observer made notes of the appearance of the smoke at frequent intervals and gave the position of the plane relative to the smoke and the sun from 9:45 a. m. to 11:20 a. m. The wind was very light but there was considerable drift of the smoke more or less horizontally. The sky was clear but the observer in the airplane was looking down into a haze layer which was rather dense in the valleys. The background for the test smoke was yellowish gray formed by gray gravel and a sparse stand of dead grass. The haze decreased with increasing elevation and the upper limit of it as seen from the airplane appeared to be at 10,000 feet above the ground.

The airplane observer made the following notes concerning the visibility of the smoke:

Horizontal distance of smoke	Elevation of airplane above smoke	Notes on visibility of smoke column compared to approximate horizontal angle between line of sight to smoke and to sun
Miles	*Feet*	
1	700	Clearly visible at all angles.
1	1, 100	Difficult to see with sun at observer's back.
2	1, 300	Clearly visible toward the sun and satisfactorily visible at right angles to sun.
3	1, 700	Visible toward the sun and at right angles but barely distinguishable with sun at back.
5	4, 000	Not distinguishable with sun at back.
5	5, 000–6, 000	Not distinguishable with sun in the 90° sector at observer's back.
5	6, 600	Not distinguishable when sun in the 120° sector at observer's back and on the border line of visibility the shadow of smoke becomes visible before the smoke itself.
5	7, 000	Identification of smoke not certain when sun slightly behind observer.
5	9, 000	Neither smoke nor shadow discernible when sun at observer's back.
5	10, 000–14, 000	Barely seen when sun slightly behind observer but satisfactorily visible when horizontal angle between sun and line of sight about 45°. Most visible when horizontal angle 0°.

The second series of tests was made to determine the effect of several visibility factors and also to determine whether an observer looking for smokes but not knowing where they might occur would miss some of them when they are no larger than the test smokes used here. The smoke from the test-smoke candle is approximately equivalent to that produced by 200 square feet of burning Douglas-fir duff and continues to issue for 4 minutes. The test smokes were set off during a 2-hour period at unscheduled times and places in a steep forested valley 16 miles long and 5 miles wide while the observation plane patrolled above, the observer knowing that test smokes would be set off. Only one candle was set off at each place. The day was clear but there was considerable haze. The visibility distance measured with the Byram hazemeter was 11 miles looking toward dark timbered backgrounds of ponderosa pine, Douglas fir, and larch. The airplane flew at 3,000 to 3,500 feet above the bottom of the valley.

Seven out of 14 smokes were discovered. Those discovered were set under the following condition: One was in dense, tall timber, 2 were in moderately dense timber, 1 was in a patch of saplings, and 3 were on gray rock-covered ground. Those missed were as follows: One in moderately dense timber, 1 among scattered trees, 2 on the shady sides of small opening, 1 in a patch of saplings, and 2 on gray rock-covered ground. The smokes that were discovered appeared as thin wisps at some moments and as rather dense columns at others. On circling them they became less visible when the sun was at the observer's back.

During both series of tests the haze cutters developed by G. M. Byram were tried frequently. The dark red filter made the small, thin smokes examined, including that from one campfire, considerably less visible but improved the visibility of landscape features. The polarized smoked glass filter had no apparent effect on smoke visibility but improved landscape visibility.

The two series of tests substantiated the previous conclusions concerning brightness or color of background and the angle between lines of sight from the observer to the smoke and from the observer to the sun.

Several general observations of factors concerning aerial detection based on the first season of experience by pilot Gene Dolman and observer George Honey should also be mentioned. They state that about 1,000 feet above the ground is the best elevation when searching for small smokes. They believe it is impracticable for one plane to search large areas such as several hundred thousand acres for small smokes like the smoke candles. If it were suspected that small smokes, such as those from small lightning fires, were in the area a time-consuming, detailed search would be necessary. They believe the scanning method of using the eyes is better than the fixed direction or detailed examination method. Their experience indicates that the contrast of the smoke against the background will be detected at a glance and that prolonged looking at the same spot would not greatly improve the chance of detection but would exhaust the observer.

These men think that a great deal more area can be covered in a shorter time by fling across the canyons rather than up and down them. The value of this choice would depend on the size of smoke, the chance of periodic appearance and disappearance of the smoke, the lighting and background positions, and the period of visibility while a canyon was being crossed.

Several inherent characteristics of the northern Cascade Range country in Washington make aerial detection of small fires very difficult. In the higher mountains the exceedingly steep, rocky slopes and the variable directions of the drainages make only the uppermost slopes and the tops of the ridges visible to an airplane in search of small smokes unless each drainage is flown separately. A greater percentage of the area is visible in the more rounded topography and more regular drainages of the foothills. Another difficulty of detection in the higher mountains is the background color and lighting pattern. The timber occurs in patches and as scattered trees which give a mottled color and shadow pattern. Many of the higher ridges are bare granite which forms a light background from numerous angles of observation of smokes rising from the timbered gulleys and slopes below.

Inventory of State Fire Control Equipment.—A combined inventory as of July 1945 shows that the 42 States engaged in Clark-McNary cooperative protection of 301,228,000 acres of State and privately owned forests are using the following major equipment items:

Steel and stone lookout towers	1, 867
Wooden lookout towers	546
Tree lookout cabs	105
Miles protection roads	33, 710
Miles metallic telephone lines	22, 137
Miles ground telephone lines	17, 992
Tanker trucks	1, 379
Transportation trucks	1, 521
Tractors	486
Graders, bulldozers, and trailers	219
Mechanized plows	380
Portable power pumps	1, 296
State-owned airplanes	5
Radios	2, 172

The States of Maine, New York, New Jersey, Rhode Island, and Texas own and operate their own airplanes for fire control, but many other States use airplanes but on a contractual basis for similar purposes. Thirty-four States use radio in varying degrees.

McLEOD TOOL DEVELOPMENTS

Lloyd A. Qualls

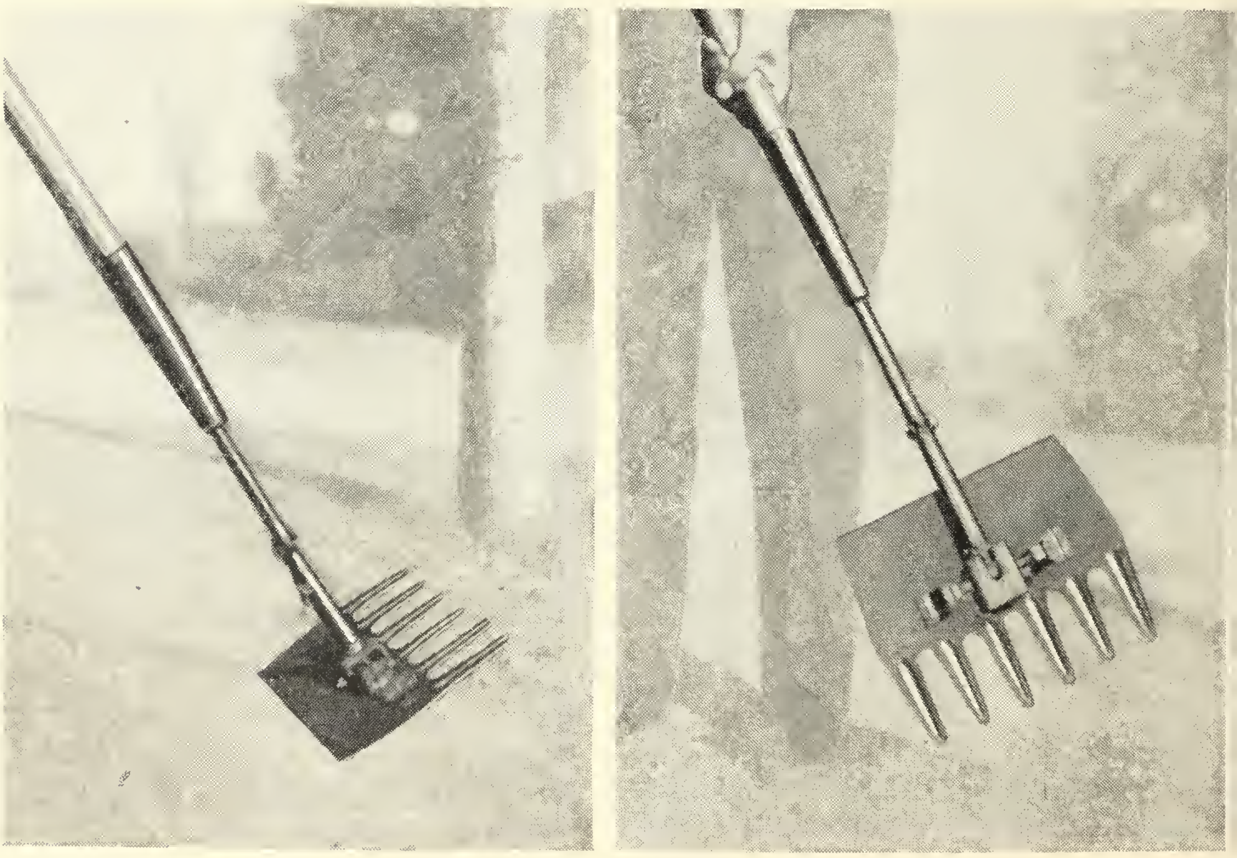
Equipment Operator, Trinity National Forest, U. S. Forest Service

Folding McLeod

The purpose in developing a McLeod tool with folding blade was to adapt the tool for more convenient packing, yet keep it in one piece.

A Kortick-McLeod was used. The triangular head of the shank was cut off and threads run up the desired length of the shank. The pipe sleeve, with keeper welded on, was slipped on the shank and the bolt used for a hinge pin welded across the end of the shank. This bolt is threaded on both ends, as the added area of the nuts on each end of the hinge pin is desirable for welding. To the nuts on the end of the hinge pins angle irons are welded and these in turn are welded to the blade. The slot cut in the channel iron is just wide enough to allow the shank to pass freely when the handle is raised or lowered. The channel iron is then welded to the blade.

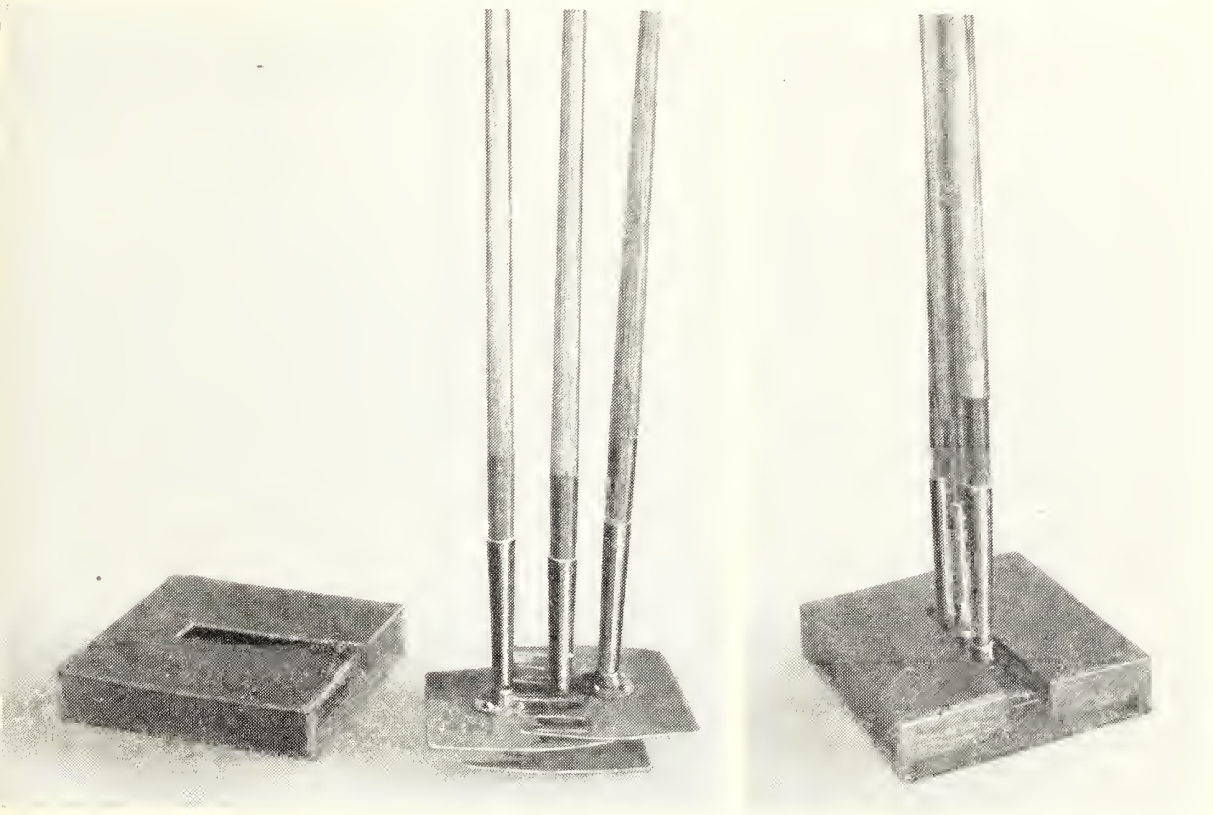
Changing over the tool adds a half pound to the weight, but less than one-fourth of a minute is required to change from the folded to the use position.



Folding McLeod tool—left, use position; right, showing folding device.

McLeod Tool Box

The McLeod tool box is made to hold three McLeod tools. Light, simple in construction, it does not use hinges, hooks, or lock pins of any kind. Inside measure is 2⅜ inches deep, 11 inches wide, and 13½ inches long. The top and bottom are of ¼-inch 3 ply. Sides and ends are made of ¾-inch material. The top has a slot 2 inches wide by 10 inches deep. The front end is made of two pieces 4½ x 1½ x ¾ inches. These are nailed to the top plywood, allowing for a 2-inch opening to match the top opening, and also providing an opening across the bottom of the front end.



McLeod tool box—left, tools and box; right, final assembly.

The tools are placed in the box one at a time, with the final assembly as shown in the photograph. Thus, the blade of the last tool in the box is held against the solid part of the front end, holding all tools in place. The handles are bound together toward the top with binder twine or rubber bands.

Combination Pulaski-McLeod

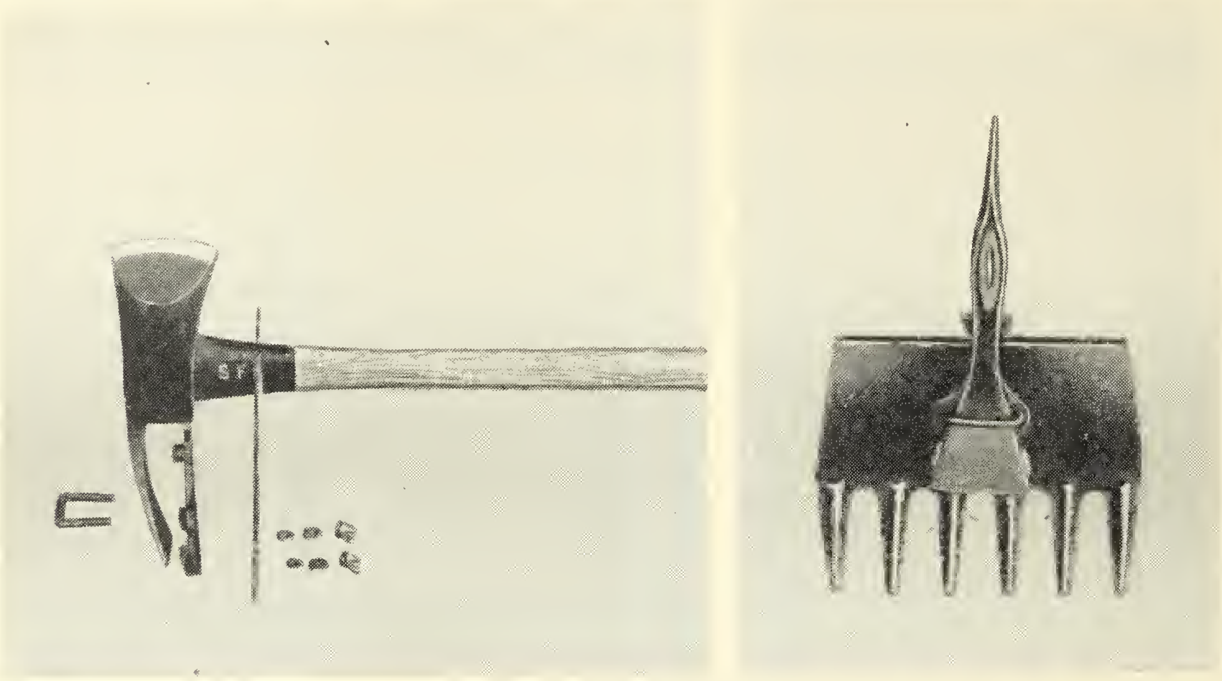
The head of a detachable McLeod tool can be attached to a Pulaski tool, thus enabling a fire fighter to carry a 4-purpose tool conveniently. The McLeod head can be carried easily in a sheath or pack and attached to the Pulaski in a few seconds.

The following are needed to make the attachment:

One **U**-bolt, ⅜-inch stock threaded both ends, bent to fit ⅜-inch holes centered 2⅜ inches apart;

Wing nuts and washers for the **U**-bolt; two ⅜-inch holes should be bored in the tool head directly under the existing holes on the cutting blade side, the hole centers to be 1⅜ inches from the center of the existing holes. The distance between the centers of the new holes should be 2⅜ inches;

An angle attachment—a piece of ¼-inch iron or steel triangular in shape. The small end has two prongs which fit snugly alongside the hammer end of the Pulaski to prevent side play. A piece of ½-inch iron is spot-welded to the main piece of metal, just below the crotch of the pronged end or "fork," giving the attached McLeod head the proper angle. At the widest or flared end of the attachment two pieces of ⅛-inch metal are spot-welded. The edges of these ⅛-inch metal "sideboards" rise about ⅜-inch above the flat surface of the attachment and act as side guides to insure against side play. The flared end at the widest point is 3 inches. The holes, as shown by the picture, are 2⅜ inches apart and act as the other side of the **U**-bolt clamp. The distance from the widest part of the attachment to a line drawn between the centers of the holes is 1¾ inches. The distance from the base edge to the crotch of the fork is 4¼ inches.



Combination Pulaski-McLeod tool—left, unassembled parts; right, assembled and ready for use.

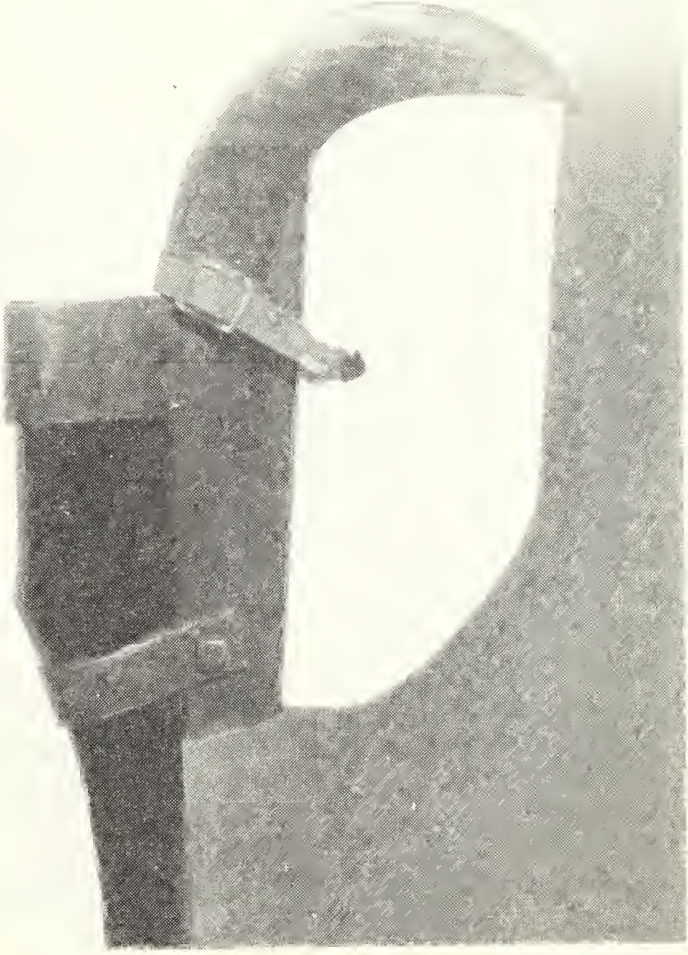
This attachment can be lightened by cutting out the center or by using a lighter gage stainless steel.

SHEATH FOR BRUSH HOOKS

HENRY SIPE

Assistant Supervisor, Cumberland National Forest,
U. S. Forest Service

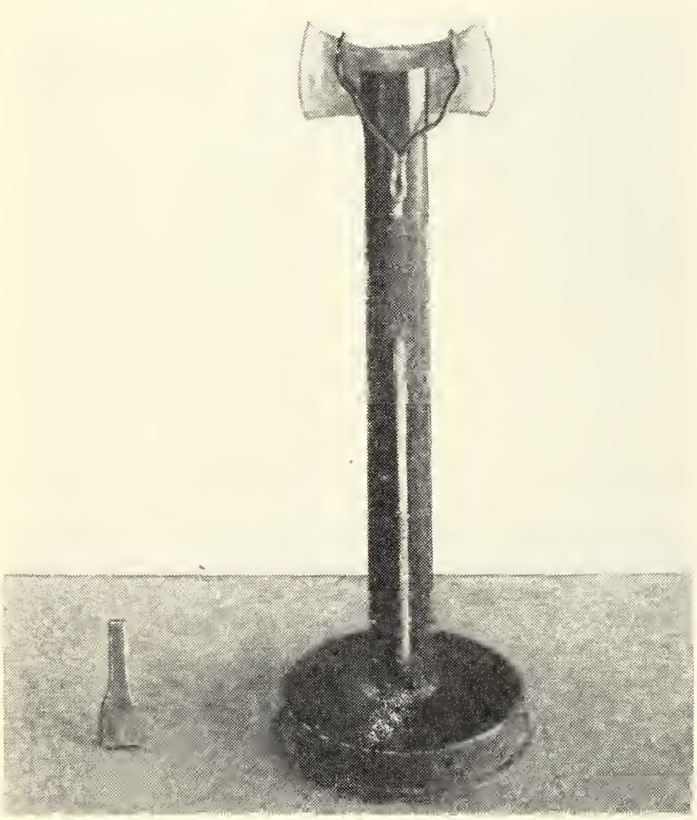
Many fire-control workers are required to carry single-edged brush hooks in their cars or other places where it is not possible to keep them in a protective slot. The sharp edge of the tool is likely to be dulled by contact with hard objects or may damage softer materials. Not the least danger is the cutting of a shoe or finger. The author has never seen a commercial sheath on the market to protect the edges of these tools.



Sheath for brush hooks.

An effective and inexpensive sheath for a brush hook can easily be made by using material available to anyone. (See accompanying picture). Select a board about ¾ inch thick and as long and wide as the cutting edge of the tool. Lay the tool on the board so that the edge and most of the shoulder of the blade is over the edge of the board. Then draw a pencil line on the wood along the blade's edge. Next saw a slot in the middle of the edge of the board as far as the pencil line. This slot may be widened with a sharp knife, file, or rasp, so that the tool edge will fit snugly. A hole should then be drilled through the board at such a point that a cord or strap can be inserted and tied around the blade to keep the sheath tightly fastened. The corners of the board can be rounded as desired.

Brush hooks commonly have various head or blade shapes and sizes. It is thus desirable and easy to make each sheath fit the particular tool it is designed to protect. A little sawing and filing will usually change the sheath to fit a tool of different shape.



Holder for dehandling axes, showing ax head in slot at top of pipe.

Holder for Dehandling Axes.—This implement is made of 2½-inch wrought steel water pipe welded to any base having sufficient area and weight, such as a truck brake drum or cat-track roller, to keep the holder vertical and prevent it from jumping. The finished height of pipe and base should be approximately the same as that of a workbench. A slot is cut in the top of the pipe on opposite sides about 2½ inches deep and wide enough to allow the ax head to drop in. The slot should be slightly V-shaped with the vertex rounded or squared.

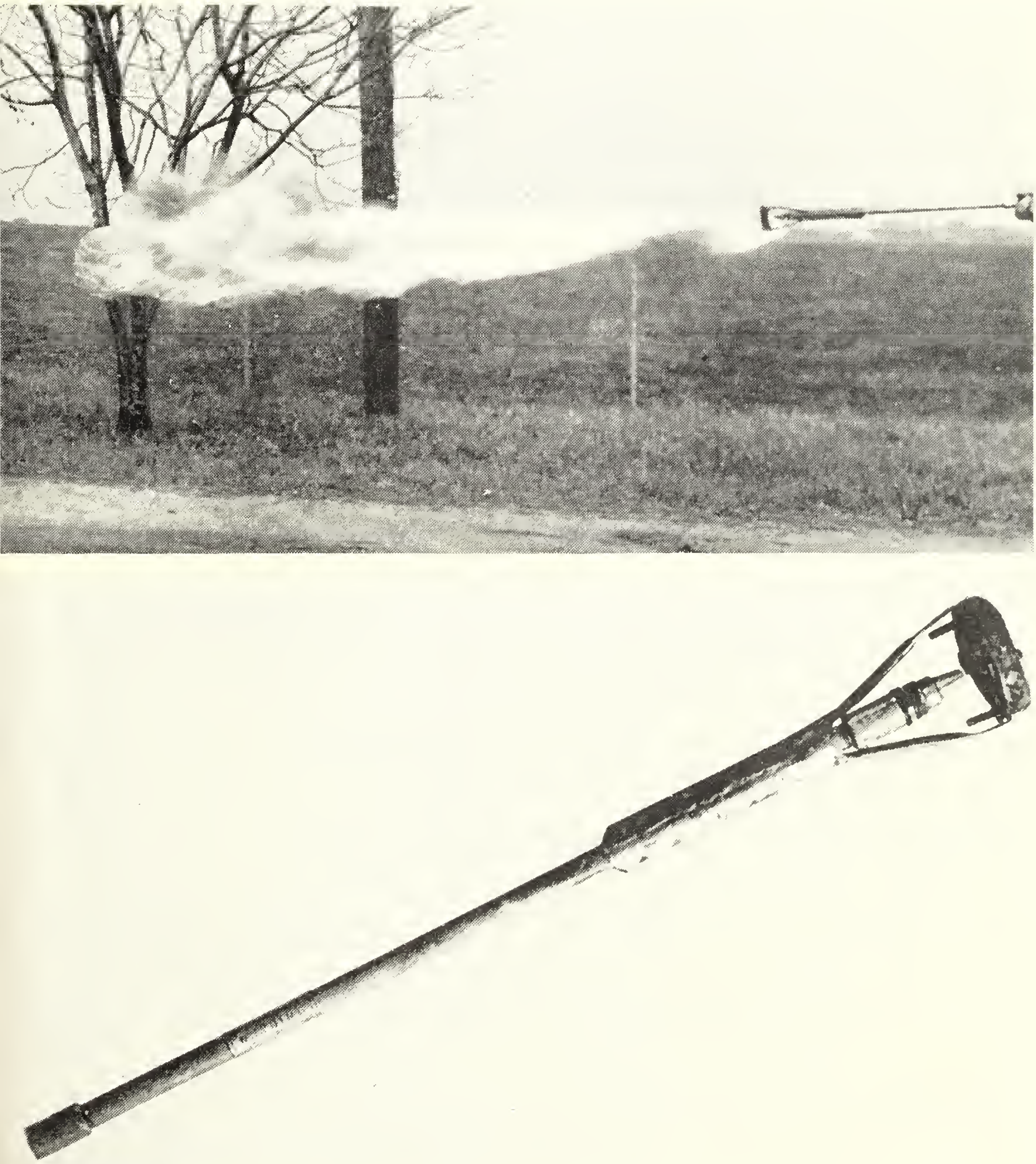
To remove the old handle, saw it off as close to the head as possible without running the saw against the ax—½ inch to 2 inches is a convenient length. Place the ax head in the holder with the wedges down. Use a handle knockout and hammer of about single-jack weight. It is not necessary to remove the wedges or drill holes. The shoulder of the handle does not need to be removed as the wood shears off readily without injury to the ax. A very tightly fitted handle can be removed in less than 1 minute.—Lloyd A. Qualls, Trinity National Forest, U. S. Forest Service.

NORTH CAROLINA FLAME THROWER

M. M. Carstarphen

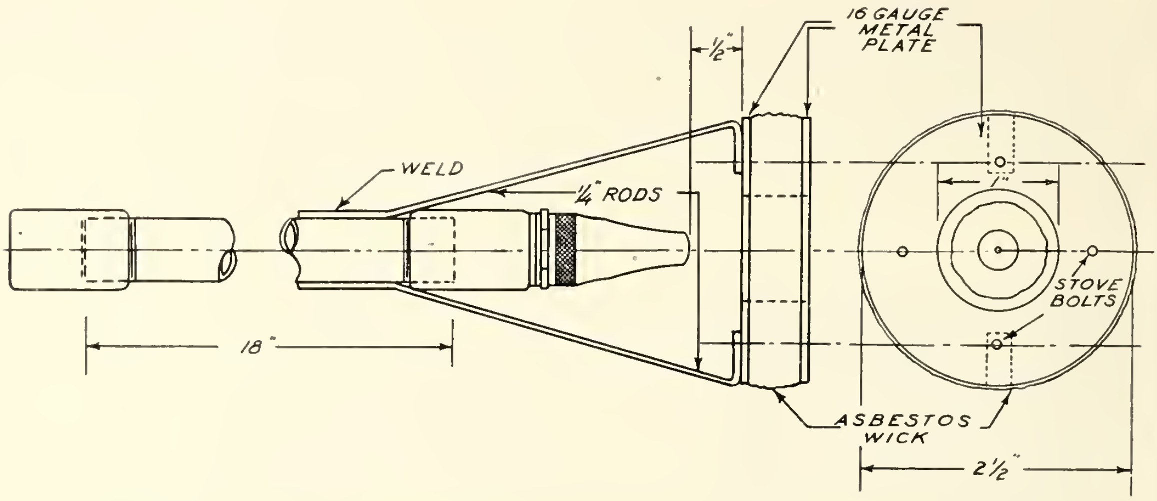
Acting District Forester, North Carolina Forest Service

The North Carolina Forest Service has developed an improved flame-thrower attachment for back-pack pumps. Its main feature is a flat disk asbestos wick with a 1-inch hole in the center, through which the kerosene fuel must pass. The circular flame of the wick insures positive, continuous ignition of the discharged fuel, a highly desirable feature.



Upper, North Carolina flame thrower in action; lower, construction details. (Photographs courtesy North Carolina Forest Service.)

The attachment consists of an 18-inch x ⅜-inch pipe extension tipped with a D. B. Smith Co. flame-thrower nozzle. A circular asbestos wick (2½ inches diameter, ½-inch thick, and with a 1-inch hole in the center) is mounted ½ inch in front of the nozzle tip. The wick is bolted between two 16-gage metal disks and held in position ½ inch in front of the nozzle by two ¼-inch rods welded to the pipe back of the nozzle. The ends of the rods are flattened and bent in ½ inch and have ⅛-inch holes drilled so that the circular wick can be bolted to them. Details of construction are shown in photograph and drawing.



Plan for making flame-thrower attachment for back-pack pumps.

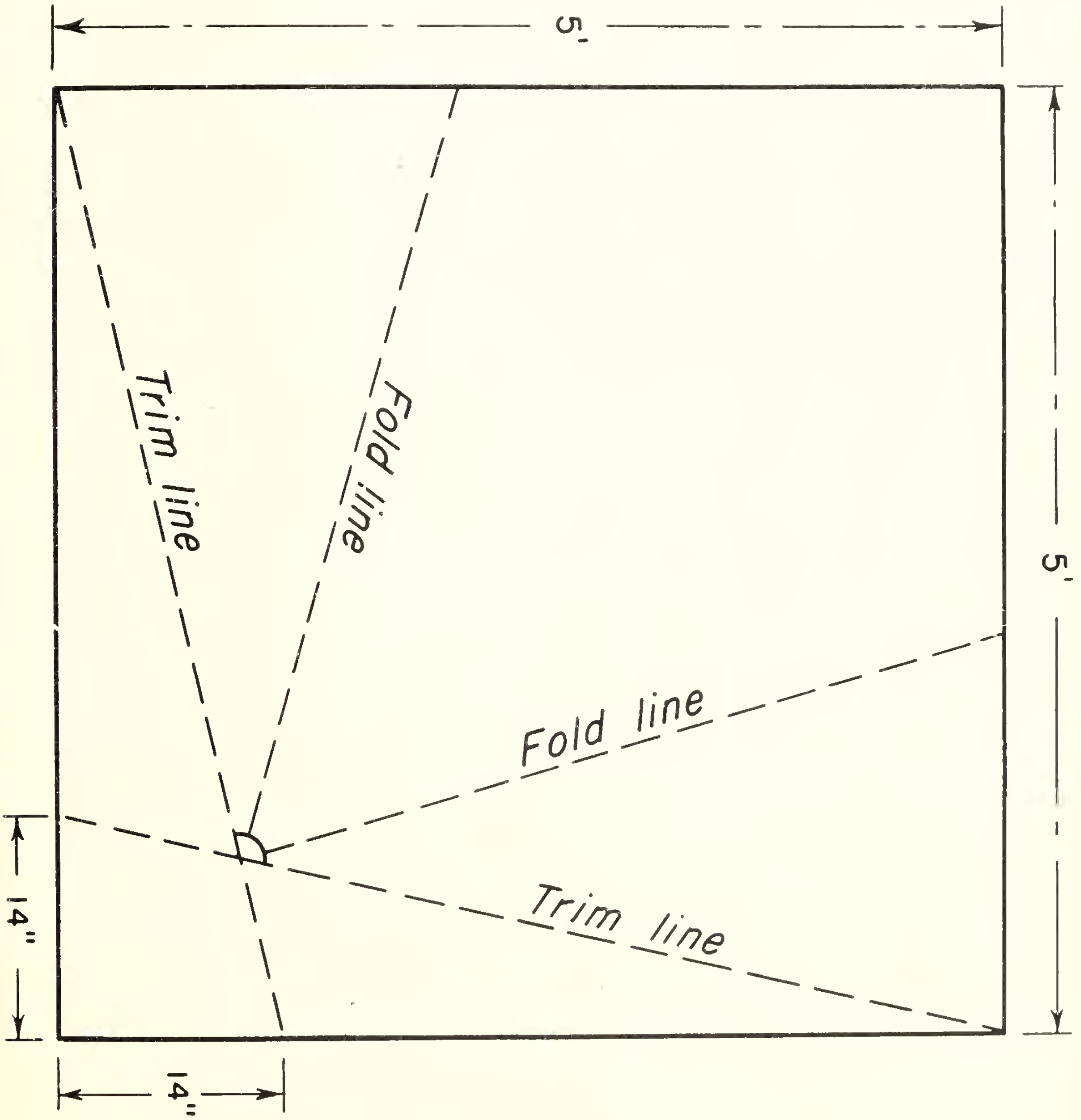
Some difficulty has been experienced in keeping the wick saturated during use of the flame thrower. But this can be overcome by placing the wick disk flat on the ground and permitting the kerosene fuel to fill up the center hole. However, a better method of keeping the wick saturated is needed.

CANVAS GRAVITY INTAKE

Curtis E. Price

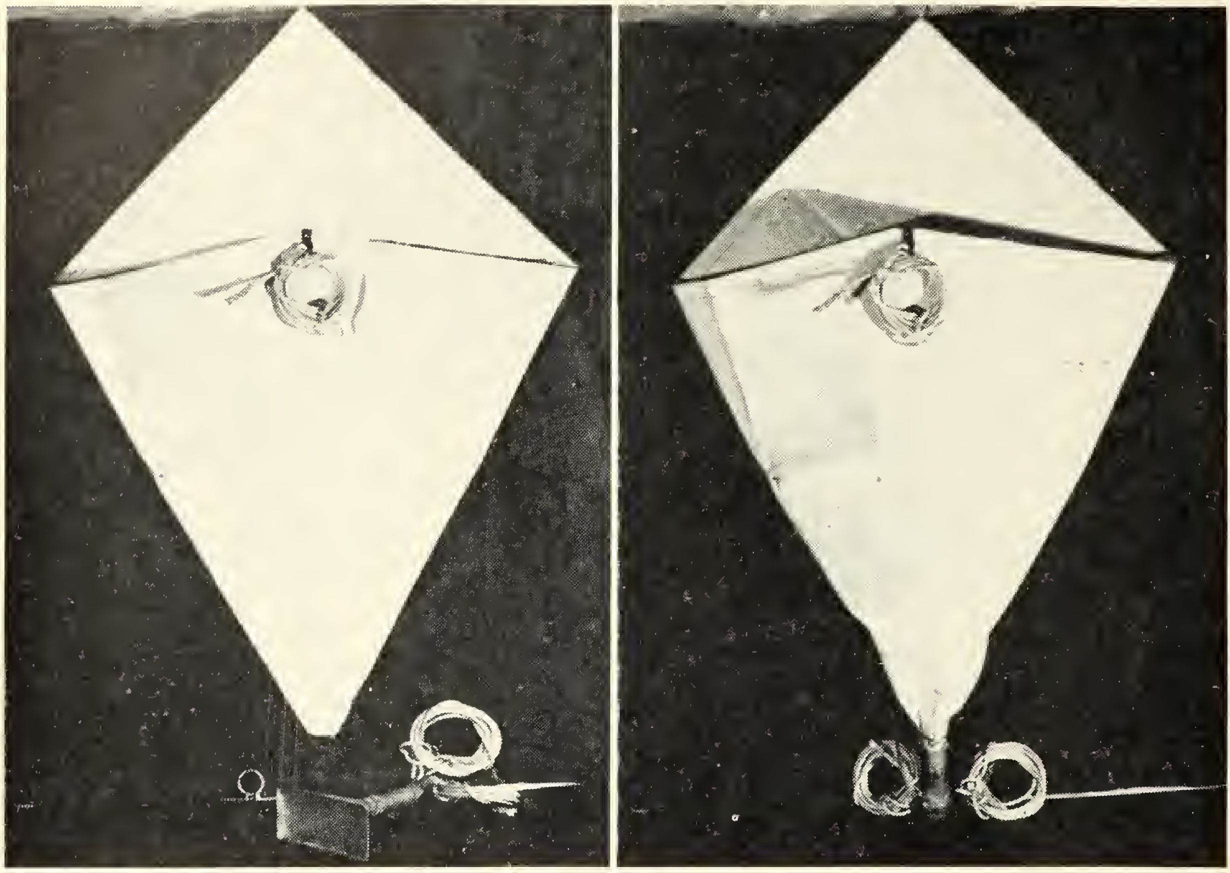
Forester, Siskiyou National Forest, U. S. Forest Service

In the summer of 1944 Ranger L. J. Cooper of the Siskiyou National Forest needed a funnel intake for a gravity water supply, something that could be installed quickly in irregular stream beds. He discussed it with Al Love, fire warehouseman, who made an intake, illustrated in the accompanying photographs, from a piece of 10-ounce canvas 5 feet square, cut and folded as shown in the sketch.



Specifications for canvas gravity intake. Trim lines are brought together and lapped 1¼ inches. The lap may be sewed or cemented.

In use, the long point of the canvas is weighted down on the creek bottom with rocks and/or mud. By means of the rope attached to the top side of the canvas, the funnel is anchored in such a way as to hold that side up out of the water. A metal funnel fits inside the canvas one and is fastened to it with a 2-inch hose clamp.



Left, the metal funnel, with screen, pipe nipple, and ropes; right, the gravity intake assembled.

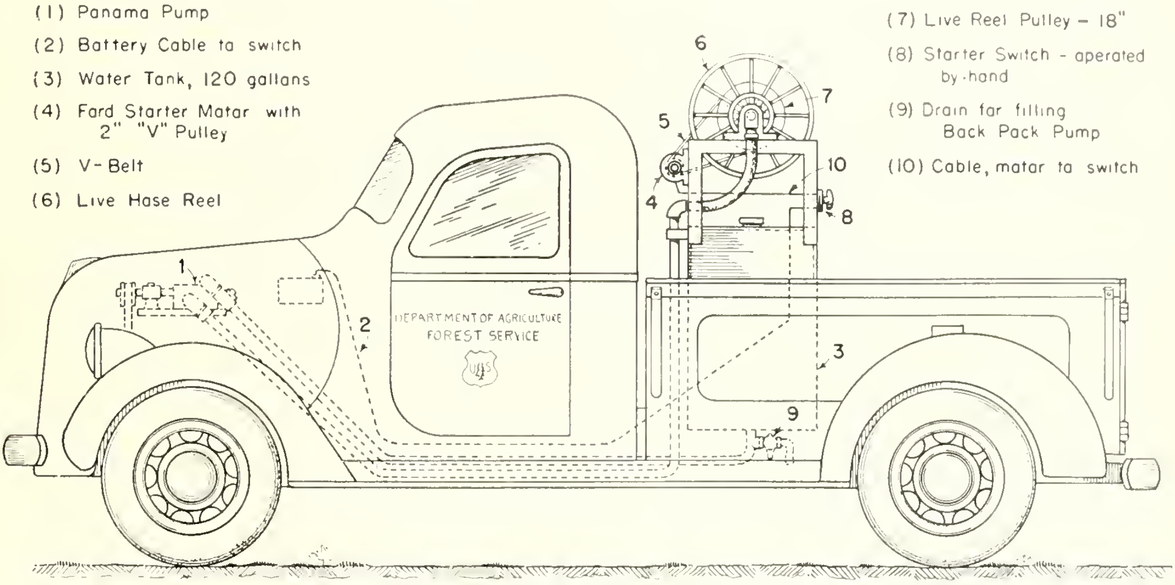
The opening to the metal funnel is 5 x 10 inches and is covered with ⅛-inch mesh screen. The outlet is brazed to a 1½-inch pipe nipple 8 inches long. A male hose coupling is welded to the outer end of the pipe nipple for the attachment of a standard 1½-inch hose. Two-inch rings are welded to opposite sides of the coupling for the attachment of ropes to anchor the intake and prevent it from being dragged by the pull of the hose. Tests indicate that this intake is better than any others tried on the Siskiyou National Forest for locations where the water supply is low and difficult to pick up.

LIVE HOSE REEL FOR PANAMA PUMP OUTFIT

M. S. Smothers

Forest Mechanic, Jefferson National Forest, U. S. Forest Service

In 1942 the Jefferson National Forest provided each ranger district with a Panama Pump mounted on a ½-ton pick-up equipped with a 120-gallon tank and 500 feet of ¾-inch hose mounted on a reel. The vehicles were not set aside for exclusive fire-control use, but were employed by the general district assistant in his regular year-round work. Thus, during the fire season he was always equipped with the pump, hose, and a tank full of water. Frequent use has also been made of them in mop-up work and in suppression of spot fires discovered along roadsides.


(1) Panama Pump
(2) Battery Cable to switch
(3) Water Tank, 120 gallons
(4) Ford Starter Motor with 2" "V" Pulley
(5) V-Belt
(6) Live Hose Reel
(7) Live Reel Pulley – 18"
(8) Starter Switch - operated by hand
(9) Drain for filling Back Pack Pump
(10) Cable, motor to switch
1
2
3
4
5
6
7
8
9
10
DEPARTMENT OF AGRICULTURE
FOREST SERVICE
US

Hose reel for Panama Pump outfit.

It was soon found that occasionally the unit had to be operated by a man working alone. Considerable difficulty was encountered by him in reeling up the hose without help. To solve this problem, a cheap but effective way was found to make the reel self-propelling. A second-hand Ford starter motor with a 2-inch V-pulley was installed on the hose reel frame; a V-belt connected the motor to an 18-inch V-pulley fastened to the reel; a starter switch mounted on the frame and connected with the motor by a piece of battery cable operated the motor; and current was supplied by the car battery through a battery cable. The drawing illustrates the method of installation.

The cost of materials was approximately as follows:

Starter motor (second hand)	$2.00
Starter switch	1.65
2-inch pulley	.50
18-inch pulley	3.00
V-belt	1.25
Battery cable (8 feet)	2.25
Total	$10.65

The mechanic's time involved about 4 man-hours and the helping mechanic an additional 4 man-hours.

POWER CHAIN SAW CARRIAGE

John W. Parker

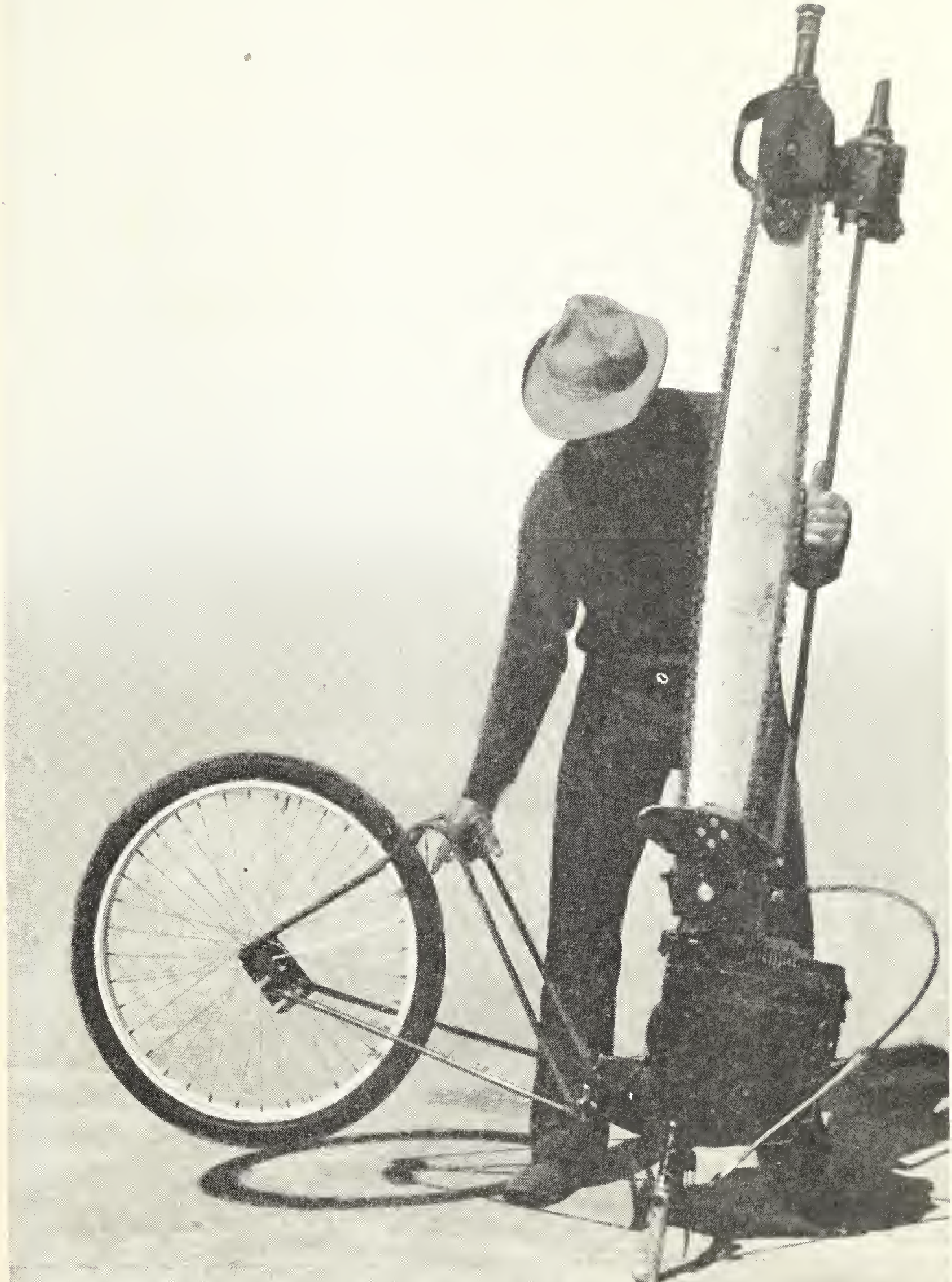
Forester (Fire Control), Boise National Forest, U. S. Forest Service

Private industry and the fire-protection organizations have used the gasoline-powered chain saws very successfully in many types of work. However, to make the use of this expensive saw worth while, production must be increased several times over and above what can be done with an ordinary crosscut saw. One drawback in the use of the power-chain saws is that they are heavy and hard to transport. To overcome the difficulty of transportation, the Boise Forest personnel has developed a light carriage which can be attached to and detached from the saw easily and which is capable of moving the saw over very rough terrain. One-half-inch airplane tubing is used for most of the frame, which makes it both sturdy and light. The total weight of the carriage is 13 pounds. The carriage was built for the Disston power chain saw, but can be adapted easily to any other similar make.

The carriage can be attached to the saw or detached from it in 15 seconds or less because of simple construction. There are no nuts or bolts to be removed and nothing to be lost or misplaced. The rear part of the saw is attached to the carriage by two bolts that fit into two holes in the frame of the saw. These bolts are tapered so that they slip through the holes easily and are bent back so that the saw cannot become detached while the front catch is in place. The front part of the saw is held in place by a hold-down clamp that fits into a ½-inch hole drilled in the abutment plate. The carriage is run on an ordinary 26-inch bicycle wheel.

Attaching the saw to or detaching it from the carriage can be done most quickly by one man as outlined in the following steps:

1. The power saw is placed on the ground.
2. The operator, using his right hand, takes hold of the front part of the carriage just to the right of the hold-down clamp.
3. With his left hand, he takes hold of the saw at some convenient point approximately in the center of the guide rail, and tilts the saw back on its handles till it is in a nearly vertical position.
4. While holding the saw in a vertical position, the two bolts in the rear part of the carriage frame are put through the rear holes in the motor frame.
5. The saw is now tilted forward until its weight is resting partly on its handles and partly on the wheel. The saw will remain in this position with only slight steadying by the operator.

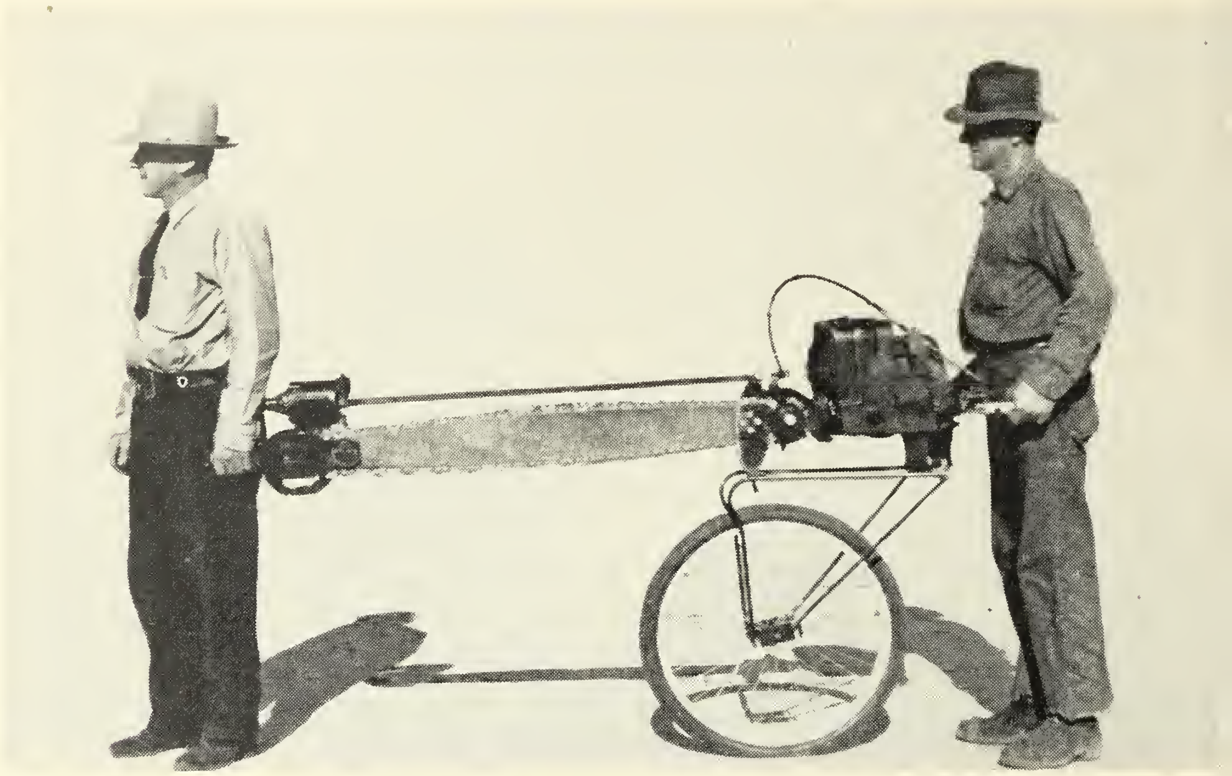


Mounting Disston power chain saw on carriage. One man can mount saw on carriage or dismount it in 15 seconds.

6. The hold-down clamp can now be engaged with the abutment plate with one hand.

7. The operator now grabs the handles of the saw and raises them to a convenient height, and the saw can be pushed wherever it is to be used.

8. To detach the saw from the carriage the process is reversed.



Disston power saw mounted on carriage. Unit can be moved by one or two men.

The saw can be moved by one or two men depending upon the terrain to be traversed. One man holds the rear handles and the other holds the tail stock handle.

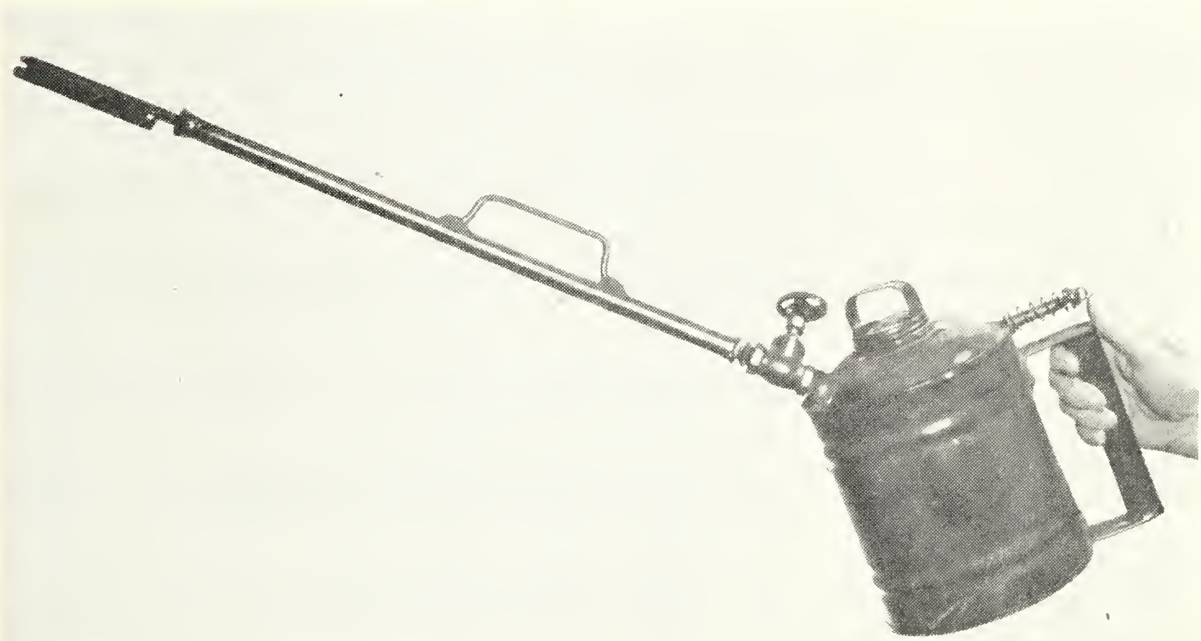
The power saw carriage can be constructed in nearly any shop by a competent mechanic. The cost of the unit is approximately $32 where one or two units are made.

THE FLORIDA DRIP TORCH

JOHN W. SQUIRES

Forest Supervisor, Florida National Forests, U. S. Forest Service

One of the most worth while developments that has come from the prescribed burning program in Florida has been a fast backfiring torch. Various flame throwers, propane torches, railroad fusees, and rakes had been tested previously. All of them had some weakness; they were either too burdensome to carry, too slow to do the job, or they didn't last long enough. Three years ago most of the backfiring was being done with an asphalt rake. When the Chief approved the large scale prescribed-burning program, it was apparent that the speed of firing would have to be increased in order to burn the necessary acreage on the few days during the winter months suitable for such burning. To burn 1,500 to 2,000 acres per day, it would be necessary to string from 40 to 50 miles of line.



The Florida drip torch.

The idea of the drip torch doubtless originated with the pressure backfiring torch which was first used on the Mathis 2-disk fire-line plow. With this torch attached on the back of the plow, it was possible to plow a line and backfire at the same time. The torch consisted of a 10- or 15-gallon gasoline tank equipped to be put under pressure. The nozzle of the feed line was placed just above a wick which was ignited, and the gasoline was thrown by pressure across the burning wick and over the plowed line. Some of the plows on the Florida National Forests still use this pressure torch. Under good conditions and with a supporting crew, it has been possible to plow 3 or 4 miles of line an hour and backfire it at the same time.

Members of the Osceola Ranger District and the Southern Forest Experiment Station at Olustee built and tested several backfiring torches in the fall of 1943. The model in use at the present time was made of a gallon kerosene can with a spout about 24 inches long, usually constructed from the inner barrel of a back-pack pump or of copper tubing. The end of the spout was filled with a rope or cloth wick just tight enough to allow the fuel to drip slowly when the spout was lowered. The principal difficulty was getting the proper type of fuel. The first tests were run with kerosene, with 1 quart of burnt motor oil added, and gave fairly good results. However, gasoline was tested with the motor oil mixture, and surprisingly the torch did not blow up. Safety experts maintain that such use of gasoline is very dangerous, so, even though the drip torch had been used for a month without an accident, it was decided that it must be tested. Two models were prepared and sent to the United States Bureau of Standards, where they were ignited and tested 50 times without accident. The Bureau, however, recommended the addition of a check valve air vent on the can and a loop in the spout as further safety precautions. One manufacturer has built a torch with similar specifications, but to date has been unable to produce more than a sample model. So far over 100 of the gallon-type drip torches have been built and used without an accident or an explosion, and 180,000 acres, which represents about 3,000 miles of back, flank, and head fire, have been prescribe-burned.

Naturally the Florida organization has learned a great deal about fire behavior and techniques for setting back, head, and flank fires. In the Florida forests most of the class C and larger fires are stopped with backfires. With the drip torch, backfiring can be done more efficiently and much faster. The speed of firing depends on the fuel being ignited.

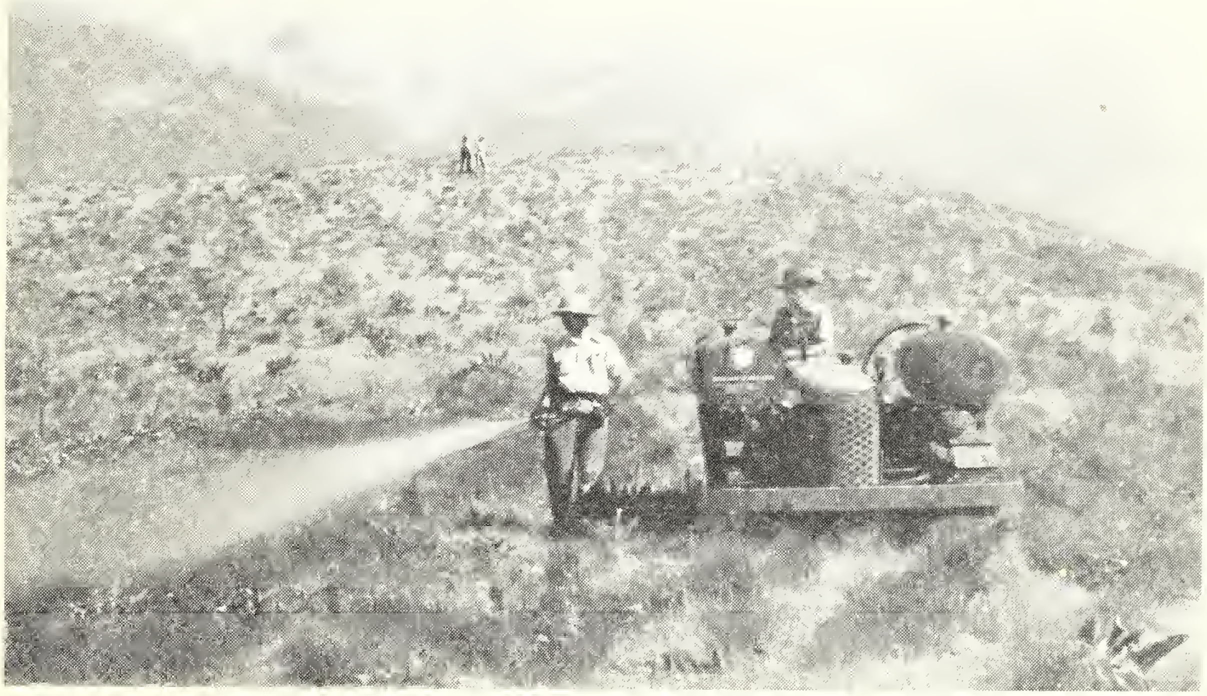
A man can string fire on the run at a rate of 5 to 7 miles an hour. The rate of firing on prescribe-burning averages from 2 to 3 miles per hour. By laying several parallel lines of fire in front of the head, the fire can be stopped with less chance of its jumping the backfire.

It has been found that with the drip torch, types that heretofore were almost impossible to ignite can be backfired. The scrub pine (pinus clausa) on the Ocala has always been difficult to backfire because there is very little fuel on the ground, but with the burning gasoline dripping on the light and scattered fuel it is possible to get a start in this type. All firemen in Florida now carry a drip torch in their pick-ups because they know that they are better able to handle a lot of grass fires by putting in a quick backfire.

FIGHTING FIRE WITH FOG

J. W. West, *Assistant Supervisor, and* Lowell J. Farmer, *Forester, Wasatch National Forest, U. S. Forest Service*

A brand new grass and brush fire-fighting machine evolved through the combination of a guayule project weed-spraying tractor and Region 5's mechanical adaptation of it, had its first work-outs this summer (1945) on the Wasatch National Forest (R–4) with some promising results. The machine consists of a model H. G. Cletrac crawler tractor with the gage widened from 42 to 55 inches by offsetting the left track 13 inches. It carries a Bean model Royal 10 pump of 17 g. p. m. capacity against a 600-pound pressure; two 53-gallon water tanks; 100 feet of ¾-inch high-pressure hose with Bean model 785 fog gun; 10 feet of 1-inch suction hose.



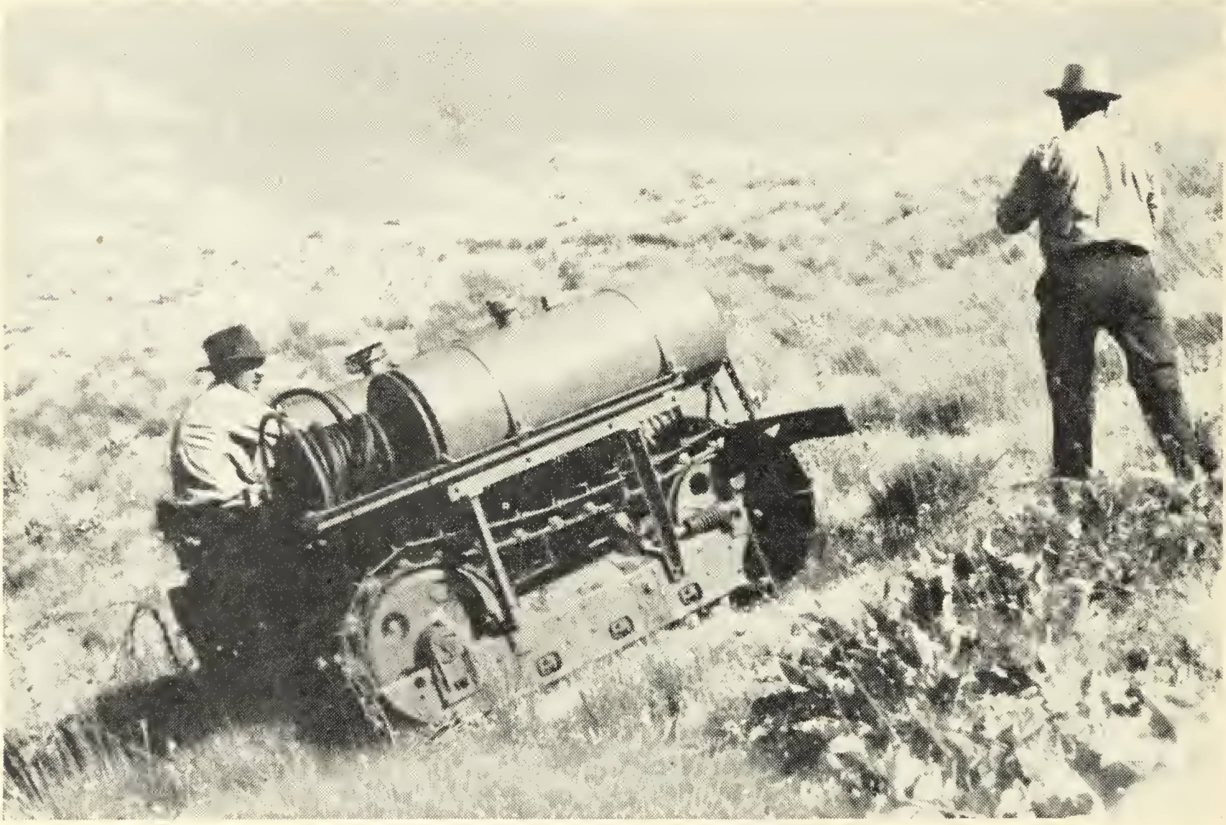
Trying out the fog nozzle on the watershed lands above Salt Lake City, Utah. The nozzleman and tractor operator easily work as a team on terrain like this.

It is estimated that Region 4's initial expense of $1,897 for the fully-equipped machine ($500 labor for conversion, $76 for freight, $1,321 for the used tractor and pump) was saved by effective performance on one fire. Three or four thousand dollars more will be needed to correct mechanical limitations and provide suggested improvements.

Operating costs total about $4.20 per hour: Operation and repair, $1.00; depreciation, $0.50; operator, $1.10; nozzleman, $0.80; helper, $0.80.

Under favorable conditions, the fog knocked out grass and brush fire at the rate of one mile of line per hour. Were this rate to be cut in half for an over-all average it still would represent marked improvement and saving over hand fighting. The machine can lay down a creeping barrage of fog and control one-half mile of grass fire in 30 minutes with one tank (53 gallons) of water. And that (experienced fire fighters will tell you) is really snuffing out fire.

In its present stage of development, the unit can climb safely and perform on grass and light brush slopes of not more than 40 percent grade. Its water supply will provide fog for 40 minutes or a continuous stream of water for 17 minutes. Experience indicates that in either mop-up or suppression the greatest efficiency is obtained by using short bursts rather than steady streams of water or fog. This calls for a skilled and experienced nozzleman who knows whether stream, spray, or fog is needed, how much, and for how long. A fog knocks out running grass fires but a stream or spray is best for mop-up work in duff and litter.



The grass and brush watershed on slopes like this above Salt Lake City are easily negotiated by the unit.

The pump attachment operating by sprocket and chain drive from the power take-off will automatically maintain any pressure for which it is set. The high nozzle-operating pressure (most satisfactory at 600 pounds) makes it impossible for the operator to manipulate the flow, that is, the nozzle trigger must be either open fully or closed.

The ideal method of operation is for the outfit to make its way around the fire line snuffing out the fire as it goes. Three men (operator, nozzleman, and helper) all working together can perform most efficiently with the helper keeping the necessary length of hose reeled off, seeing that it does not catch, and helping the driver spot the best line of travel. Both nozzleman and helper get the best results on foot where they are free from the uneven motion of the tractor.

For highest efficiency careful supervision and pretraining are required. On one fire the fire boss directed the machine to attack at a place that was, in the judgment of the operator, not traversible. As a result the outfit became hopelessly stuck and remained useless for the remainder of the suppression work.

The fire fogger can operate safely up to a 40-percent grade on country like this

Performance tests conducted May 24 and 25, 1945, on the Los Padres National Forest and during July on the Wasatch National Forest showed that an improved machine should:

1. Be able to traverse slopes up to 50 percent through moderate brush.
2. Carry about 150 gallons of water or fuel in enlarged tanks.
3. Have increased gear ratios for more stability and speeds as low as 1 mile per hour forward and in reverse.
4. Have lengthened track assemblies with more of the load placed forward for better balance.
5. Have increased size of sprocket on power take-off to prevent overheating.
6. Have power-driven fuel pump to insure carburetor feed on steep slopes.
7. Have redesigned safety platform for nozzleman or riders.
8. Have rack for suction hose when not in use.

The test unit is considered, by those who have seen it in action, "a promising and effective fire fighter. With the added features shown by these tests to be needed, it can be made into a most efficient brush and grass fire-fighting machine.

THE FOGGER'S VITAL STATISTICS

Tractor:
- Model—HG42 Cletrac.
- Type—Track layer.
- Track width—10 inches.
- Ground contact—50 inches per track.
- Tread—55 inches (offset).
- Right half—21 inches.
- Left half—34 inches.
- Maximum pull—2,800 pounds.
- Weight—3,000 pounds.

Engine:
- Make—Hercules 3 x 4.
- Type—4-cylinder gasoline.
- Maximum horsepower—
  - 19.4 belt.
  - 14.0 drawbar.

Speeds:
- Forward—
  - First—2 miles per hour.
  - Second—3 miles per hour.
  - Third—5 miles per hour.
- Reverse—2.35 miles per hour.

Pump:
- Make—Bean.
- Model—Royal 10.
- Type—Triplex reciprocating.
- Discharge capacity—17 gallons per minute at 234 revolutions per minute.
- Working pressure—600 pounds per square inch.
- Weight—280 pounds.

Tanks:
- Type—Cylindrical with 2 baffle plates.
- Capacity—53 gallons.
- Number—2.
- Mounting—Directly above tracks.
- Dimensions—Diameter 20 inches, length 48 inches.

Accessories:
- One live hose reel with capacity for 100 feet of ¾-inch high-pressure hose.
- Ten feet of 1-inch suction hose complete with couplings and strainers.
- One model 785 Bean spray master fog gun with removable tips and a discharge capacity of from 6 to 15 gallons per minute.

Total weight:
- Tanks empty—4,700 pounds.
- Tanks filled—5,600 pounds.

NEW AX SHEATH

V. C. Hallin

District Ranger, Trinity National Forest, U.S. Forest Service

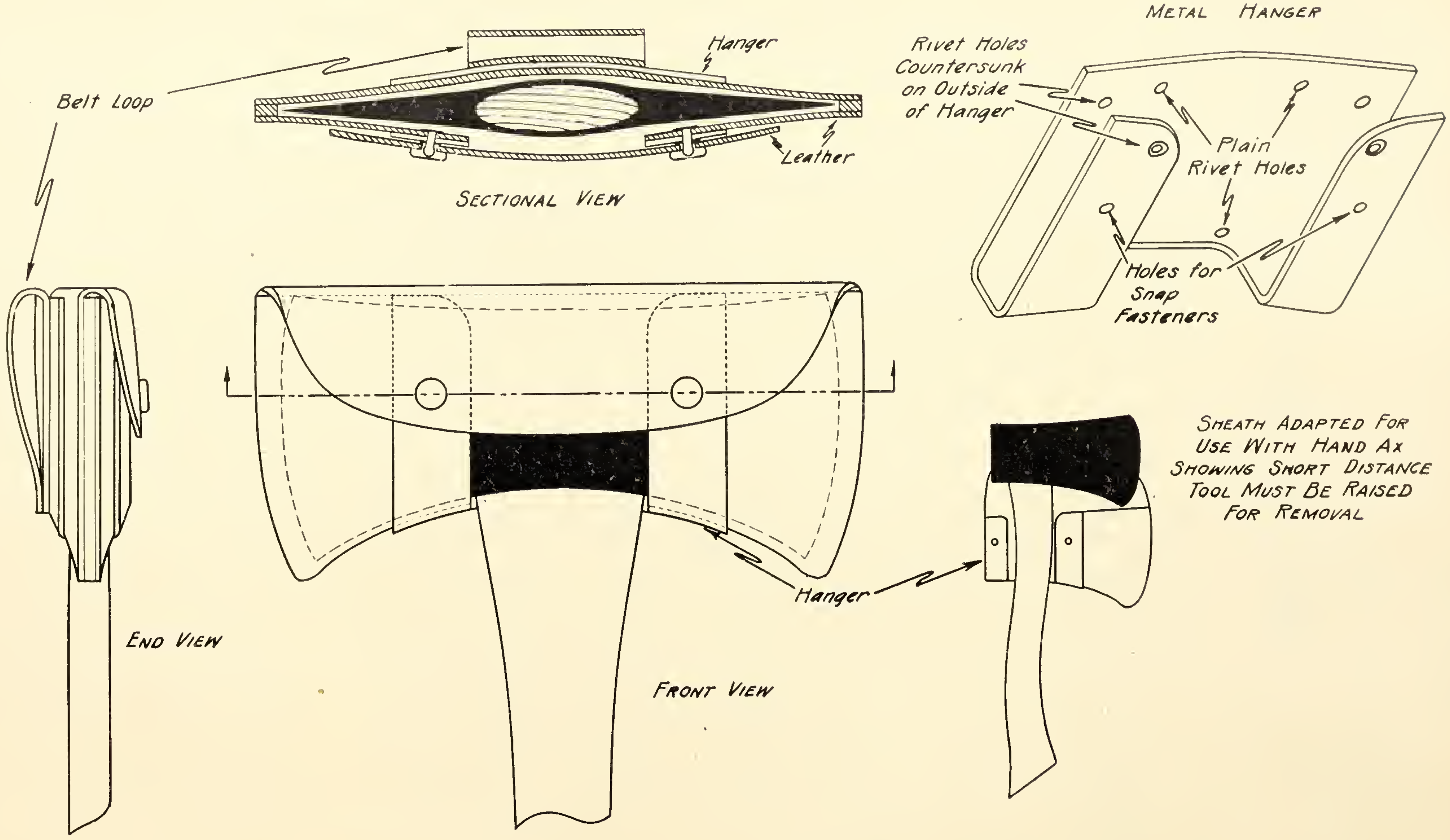
Inconvenience in sheathing and unsheathing has probably been the main obstacle to greater use of the conventional ax sheath. The same might be said about the standard carrying case for the light ax and hand ax. Since these are more readily carried at the belt than the regulation ax, the average woodsman will frequently continue the two-handed struggle every time he sheaths or unsheaths his hand ax, so that he may have his hands free for other duties while not engaged in chopping. In spite of its awkwardness, however, even the standard sheath has many advantages. It protects the tool from the elements, guards it against corrosion and abrasion, provides a convenient means of transportation, and is a safeguard against most accidents which might occur if cutting edges were exposed.

The writer, believing the woodsman should have better access to the tools which are his mainstay on the trail or fire line, in cruising timber, or on almost any other type of woods work, conceived the idea of a new type of sheath. This provided for encasing the central portion of a double-bitted sheath in a metal hanger, and cutting an opening through the outer side walls of both hanger and sheath to permit side entry of the ax handle. Two snap fasteners to lock the flap, and attachment of the belt loop to the back, complete the job. With the ax in sheath suspended from the belt, it is easy to grasp the flap and disengage both fasteners, grip the ax handle 6 to 8 inches below the bottom of the sheath, raise the ax until the head clears the hanger, and remove the tool with a sideward movement—all in a single-handed operation. Return of the ax to the case is almost as easy.

Advantages of Sheath

With any sheathed ax carried at the belt, there is always the possibility of taking a fall, catching the end of the handle in the ground or on some object, and then through failure of the flap fastening device, or because the latter is left unlocked, forcing the ax head from the sheath into a dangerous position. The Hallin holder will not entirely eliminate these dangers, but it does provide a greater opportunity for the ax to fall clear of the sheath.

The hanger type of carrier is not limited to the double-bitted ax. It may be adapted to the pole ax, hand ax, hatchet, marking ax, hammer, or almost any tool that can be suspended between two nails driven into a wall. The use of the hanger sheath for the marking hammer would do much to simplify the scaler's job. Similarly, the hanger sheath could be utilized to facilitate the work of the fire fighter, lineman, carpenter, timber cruiser, and many others.


Belt Loop
Hanger
Leather
Sectional View
Metal Hanger
Rivet Holes Countersunk on Outside of Hanger
Plain Rivet Holes
Holes for Snap Fasteners
End View
Front View
Hanger
Sheath Adapted For Use With Hand Ax Showing Short Distance Tool Must Be Raised For Removal

Double-Bitted Ax and Sheath

/olume 7 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

NITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1946

Contents

Page
Using bloodhounds to prevent forest fires 1
D. W. Beck
The Forest Service adopts FM radio 5
Harold K. Lawson
Airborne cooperation in Region 2 7
The profiling slide rule and its use 8
Aubrey L. Haines
How much time does it take to catch a firebug 13
Henry Sipe
Forest-fire gasoline and oil kit 16
Fred G. Ames
Method for repair of canteens 19
Dean M. Earl
Hot food for fire fighters 20
R. H. Williams
The F. B. I. cooperates with the Forest Service in fire prevention 22
B. F. Seizert
Fire-camp trailer 24
Leslie S. Percey
Forest fire fighting equipment demonstration 26
Division of State Cooperative Fire Control, U. S. Forest Service
A converted milk truck makes a hot food dispenser 28
K. E. Klinger
Building a cooperative tanker 30
A. G. Randall
The Louisiana fire jeep 33
Louisiana Forestry Commission
A new mobile flame thrower 36
Henry Wertz, Jr. and C. Vernon May
Foresters aloft in '46 39
P. A. Thompson and D. M. Thompson

USING BLOODHOUNDS TO PREVENT FOREST FIRES

D. W. Beck

Forester, Eastern Region, U. S. Forest Service

Many fire-control men have felt the urge to use bloodhounds to find persons guilty of causing forest fires. Relatively few, however, have actually employed them and determined their value in fire control. Some men hesitate for fear of public opinion or the possibility that grudge fires may follow use of dogs. Others point out that evidence obtained in this way is not admissible in court. Still more just don't like dogs or understand them.

Dogs on the Job

In certain areas bloodhounds have been used enough to prove their worth in fire prevention. Their chief value is in reducing the number of incendiary fires. Dogs may trail and find the guilty persons or scare them so thoroughly that they will start no more fires. In many areas the very fact that fire-control men have a bloodhound available reduces man-caused fires. In the Eastern National Forest Region dogs have been used with marked success on the Monongahela National Forest in West Virginia and on the Cumberland National Forest in Kentucky. The State of West Virginia has also used hounds successfully in reducing fires in the hot-spot southern section of the State. Good results have also followed the use of dogs on the Ouachita and other national forests in the Southern Forest Region. In every case public comment on the successful conclusion of a case has been, "It served him right," or "Now they really mean business."

A few successful fire-law-enforcement cases where the dog finds the suspect do much to increase the prevention value of the hounds. On the other hand, some hard-luck cases (and anyone who uses hounds will have them) will lower respect for the dog. A good dog has a 50–50 chance of pointing out a suspect. Hot, dry weather conditions and old trails work against him. He needs a sure starting point, and it should not be held against him if more than one man passed that point.

Shall We Use Dogs?

Several considerations, including the local point of view, must enter into the decision of the fire-control man to use bloodhounds. Do the persons who start the fires travel by foot? Are they local people or "outsiders"? Can the proper man be found to train, handle, and care for the dog? How can the most favorable public reaction to use of the hound be obtained? What weight will be given the dog's evidence in local courts?

A bloodhound is not a substitute for a well-trained investigator. Very few court cases have been won on the hound's evidence alone. The dog will do his part in most cases by following the trail to the man or to the point where he leaves no trail. His trailing will indicate who the suspect is and give reasonable assurance that the man was at the point where the hound picked up the trail. Once the suspect is determined, it takes hard work and properly timed action to get all the facts for a court case. With the information supplied by the dog's trailing, the investigator can usually do the rest of the job.

English bloodhound Texas Black Sam with Fire Control Assistant Ledford Perry at Buck Knob Lookout, Laurel District, Cumberland National Forest, Ky.

Bloodhounds are not infallible; they differ even as people do. Some have a good nose, some don't; some work slowly, some fast; some will work with anyone, some only with a trainer who can handle them. All work better with a person to whom they are accustomed. Give the dogs every possible "break" on their first few cases and so help to build local respect for their ability.

If the decision is made to use the dogs, the job must be a thorough one. Very few dogs are suitable for fire law enforcement. Training is even more important than pedigree, but dogs purchased for a fire job should have both. Experience in using bloodhounds on the national forests in Arkansas, West Virginia, Virginia, and Kentucky shows that the best results are obtained by purchasing dogs 3 to 5 years old with at least 2 years' intensive training in trailing. Good dogs usually cost from $100 to $200.

Care of Dogs

Dogs require good care, good food, and a comfortable kennel with a good, well-fenced yard. They should have fresh water at all times. Straw should be changed at least every 2 weeks and the kennel kept clean. They should be washed with flea soap regularly and should be inoculated for rabies and examined for heartworms annually. Dogs should be wormed when necessary. Keep the public away from the kennel. Accustom the dogs to working with a local man. A man who does not like dogs will not do a good job. A trial run once or twice a week during periods when the dogs are not being used will keep them in good condition.

Trailing

Bloodhounds are trained to follow men. They will not follow a horse and cannot trail a man if he gets into a car. A great many cases end for the hound where a car has been parked. From this point on, the investigator must use other methods.

Dogs differ in their trailing methods. Some get the scent from bushes or even through wind currents. Such dogs sometimes short cut the exact trail. Some trail with nose to the ground, tail high. Most of them are difficult to hold, particularly on a downhill trail or through bushy or rough areas. Some dogs bay on the track; some trail silently, depending on their training. A silent trailer is preferable for obvious reasons.

When dogs are taken from the kennel for a chase, they should have both harness and collar in place. The leash should be attached to the collar until the dog is ready to trail. Hold the leash close to the dog's neck to prevent trailing until the desired starting point is reached. When trailing, change the leash from collar to harness and point or show the dog the starting point. Then take it easy and he will soon strike out on the trail. Some dogs get car sick. It is best not to feed them just before they are expected to work.

Local Requests for Use of Dogs

Frequently there are requests for the dog's services in work other than fire cases, once he has shown that he can work out a trail. Forest Service dogs have found persons lost in the woods. Calls are received from local police officers for the use of the dogs in cases involving everything from murder to theft. To assist in these cases on request takes the dog and handler from their regular duties. A local policy must be developed for handling these requests.

Summary

If the fire control administrator decides to use bloodhounds to clear up hot-spot areas, he should buy the best trained dogs obtainable The best possible man should be hired to handle them. It is important that the dogs be given every advantage on their first three or four cases. They should have a good starting point. If the fire control man takes the attitude that every possible means must be used to stop fires from starting, public reaction will be favorable. Additional work will be needed to close each case satisfactorily after the dogs do their part. It must be recognized that dogs will not do the whole job and that other prevention methods are still required.

In most cases the use of dogs markedly reduces man-caused fires in areas where they have been numerous.

THE FOREST SERVICE ADOPTS FM RADIO

Harold K. Lawson

Radio Engineer, Radio Laboratory, U. S. Forest Service

If you are planning to install radio communication or to expand or revise your present facilities, you will be interested in the following discussion of the FM radio equipment which the U. S. Forest Service has adopted.

The form and characteristics of the new equipment are not described in detail. It is of interest to know, however, that the portable and mobile equipment is being designed to incorporate two fixed transmitting frequencies and only one fixed receiving frequency.

Many radio communication failures are due to equipment manipulation—especially the tuning of radio receivers. A fixed tuned receiver completely eliminates the possibility of maladjusted tuning or stand-by on the wrong frequency, both of which are prime causes for radio communication failures. It also eliminates all tuning knobs and controls and brings radio nearer to the simplicity of the telephone.

Methods of obtaining maximum radio network performance and traffic handling capability with a minimum number of frequencies, by use of the equipment now under development, will be discussed in a future issue of Fire Control Notes.

Forest Service communication officers and others have asked why the Forest Service radio equipment program did not follow the current trend in the use of frequency modulation (FM). In the first place, amplitude-modulated (AM) sets cannot communicate directly with FM sets, and our present investment in AM equipment must be considered before this equipment is isolated from our communication systems. Also, until very recently it has not been possible to produce truly portable FM radiophones because of their bulk and inherent complexities. Forest Service radio use is so intimately tied to portable communication service that, regardless of any advantages, FM could not be considered until portable equipment development was an assured fact. New techniques, parts, and materials now make it possible to produce portable FM radiophones.

Practically all commercial development of emergency service radio equipment is now centered in the FM field. Many law enforcement and similar agencies which formerly used AM have changed over to FM. Because of these facts and the technical advantages of the new system, we have swung our VHF radio development program over to FM. This decision is of major importance in our communication planning and execution.

A brief resume of facts relating to the subject of AM–FM follows:

1. Under identical conditions of frequency and power, FM radio waves travel in an identical manner and both will have the same effective strength at a given distance from the transmitter. In other words, under identical conditions, one is transmitted as effectively as the other.

2. Under conditions of absolutely noise-free radio station locations the effective communication range of the two systems will be nearly identical.

3. Under conditions of strong natural or man-made electrical interference FM signals are usable when AM signals may be completely drowned out by noise.

4. Precipitation or rain static that can completely disable an AM radio system is not heard on FM equipment.

5. The interstation noise-silencing system (squelch) on an AM radio receiver is subject to false operation by electrical noise and static bursts and allows blasts of noise to issue from the loud-speaker when the receiver is on stand-by. FM squelch is almost entirely free of such false operation. This factor allows noise-free stand-by in mobile service and in offices and similar installations where the usual loud-speaker background noise is objectionable.

6. Certain technical characteristics of an FM radio receiver make it possible to produce simpler and more reliable automatic radio relays or repeaters with this system than are possible with AM.

7. Manipulation of FM and AM equipment is practically identical, and no new operating problems arise from change of system.

8. Radio operating frequency distribution as between districts, forests, and regions will, at least for the present, remain as for AM. Further experience with FM may point to the possibility of closer geographic frequency repetition than is possible with AM, but this must await confirmation through use.

9. Basic equipment types will not be altered in the change-over to FM. We will continue with portable, semiportable, mobile, and repeater types of equipment. The user will not find any unusual differences in the two systems, and the net gain will be apparent only as a sum of the individual improved characteristics, which in turn will mean an over-all improvement in quality and reliability of service.

10. The change-over to FM affects only our VHF equipment. Our MF and HF frequency bands, which employ equipment types such as SPF and M, will remain the same.

We are still forced to carry out our own development and design of portable units, but we hope that much of our mobile and fixed station equipment can be obtained from commercial sources at less cost than that for custom-built items. Cost of the new equipment can only be estimated roughly, but should not vary greatly from that of comparable AM types.

The radio laboratory cannot possibly complete all items of equipment in time for contracted production in 1946. It will accordingly concentrate on the portable design in an attempt to be ready for quantity production by January 1, 1947. In the meantime, an attempt has been made to interest commercial concerns in some modifications of their standard mobile equipment to meet our needs. Other items, such as lookout radiophones and repeaters, will follow.

Transition will be based on removal of AM from one area to supply the needs of other areas and replacement of the shifted equipment with FM. This will prevent immediate obsolescence of usable AM equipment by concentrating it in selected areas that have an appreciable amount of AM equipment and need additional units. The logical starting point for introducing FM should be an area in which adjacent district, forest, or regional intercommunication is a minor factor and which has a reasonably well self-contained radio net.

Such a program will allow correction of certain undesirable radio equipment distribution problems which may now exist. At the same time, full opportunity should be taken to carefully plan equipment choice and distribution for the new networks. There are bound to be conflicts in this process before the entire AM system is liquidated by age and obsolescence, but there is no reason to discard usable AM sets immediately. A small amount of new AM equipment may be necessary in some instances, but every effort will be made to keep such purchases at a minimum.

Airborne Cooperation in Region 2.—Forest fire cooperation has reached a new high on the Harney National Forest, where Ranger Everett A. Shipek reports the following:

"Harry D. Putnam, Forest Fire Warden at Burdock, S. D., uses his private plane, a Cub J-3, to spot and suppress forest fires. While in Dewey, S. D., June 29, Putnam, a veteran of the American Air Force, received word of a fire on the Elk Mountain District of the Harney National Forest. Taking a local man with him and picking up fire tools at Dewey, he scouted the fire with his plane. Landing in a field within one-half mile of the fire, the two men controlled the 0.2 acre lightning fire within a few minutes. Warden Putnam's plane is an important factor on this portion of the forest where the high hazard makes minutes count in fire control."

THE PROFILING SLIDE RULE AND ITS USE

Aubrey L. Haines

Ranger, Yellowstone National Park

The potential value of a slide rule in checking the intersection of a line of sight with distant topography in making visible area maps was first brought out by Rudolph Stahelin in 1932.[1] Techniques were developed and perfected to put the slide rule to work in field sketching of visible areas by the California fire research group in 1932–35 and have been fully described in published material.[2]

District Ranger Albert D. Rose, of Mount Rainier National Park, helped to develop the original rule and made many tests with it while he was fire dispatcher. He found that a fire can be located in from one-third to one-half the time required by graphic profiling and that errors due to paper distortion and incorrect plotting of the vertical angle are eliminated. The following statement from Mount Rainier National Park is based on 6 years of thorough trial: "The accurate and rapid results obtained in plotting fire locations by use of the profiling sliding rule * * * has convinced us at Mount Rainier that it is the most reliable instrument available for such purposes."

In recent years the technique has been neglected. The author brings the method to attention again and shows how it may be adapted to regular lookout use by means of a specially constructed slide rule. The technique is necessarily limited to areas for which reasonably accurate topographic maps are available.

Locating "One-Shot" Fires

The profiling slide rule described in this article provides a speedy and accurate solution for a difficult fire problem. Rugged topography or poor visibility may make it impossible to observe a forest fire from more than one lookout station. The lookout observer usually has little to guide him in judging how far away the fire is. Phototransit pictures are useful, but often inconclusive. If a good topographic map is available, a profile of the terrain can be constructed to determine where the line of sight intersects the ground. This can be done in two ways; graphically, with varying accuracy and loss of valuable dispatching time, or mathematically. The profiling sliding rule, developed at Mount Rainier National Park during the 1938 fire season, makes the mathematical solution practical by simplifying the necessary calculations. It has proved satisfactory for locating "one-shot" fires, checking doubtful triangulations, training new lookout men, and making seen-area studies.

---

[1] Stahelin, R. Visibility maps constructed with the slide rule. Jour. Forestry 30: 983–987, illus. 1932.

[2] Show, S. B., Kotok, E. I., Gowen, G. M., Curry, J. R., and Brown, A. A. Planning, constructing, and operating forest-fire lookout systems in California. U. S. Dept. Agr. Cir. 449, 56 pp., illus. 1937.

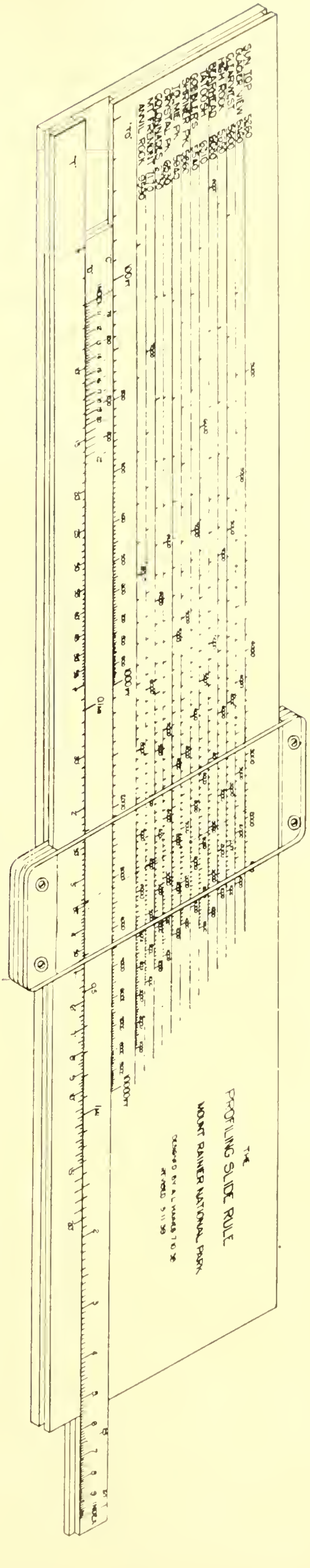
Description of the Profiling Slide Rule

This specialized instrument is designed for use by men with no knowledge of the theory or operation of slide rules. It is 32 inches long by 6 inches wide. The large size is not a disadvantage in a purely office instrument. The body is built up of three layers of 3/16-inch "Masonite" board worked to size with a saw and rasp and joined with waterproof glue and a few brads. The slide is 1 inch wide and is built up of two layers. Wood is not satisfactory for the con-truction of the slide rule, since shrinkage or warping will cause the slide to bind.

The three working scales, the tangent T on the lower limb, the distance D on he slide, and the tangent-offset TO on he upper limb are logarithmic. Each is omposed of three cycles, with the first ycle beginning at the normal position of he left index. The length of the cycles llows graduation of the scales directly rom logarithmic tables of numbers and ngular functions.

The scales are graduated as follows: Tangent T graduation marks are placed y reference to a table of logarithmic angents of angles. The mantissa of he value is multiplied by 10 and scaled ff as inches from the left end of the ycle in which the graduation mark belongs. For example: The mantissa of he log-tangent of 5 minutes is 0.1627, which, multiplied by 10, places the 5 minutes graduation at a point 1.627 nches from the left end of the first cycle. Graduation marks are placed at 1-minute ntervals from 5 minutes to 1°; at 5-minute intervals from 1° to 5°; at 10-minute ntervals from 10° to 15°; and at 1° ntervals on up to 20°.

Distance D graduation marks are laced by reference to a table of common ogarithms of numbers. The procedure ollowed is the same as in graduating the angent scale. The first cycle is graduated at 0.2-mile intervals from 10 to 15 miles; at half-mile intervals from 15 to 0 miles; and at 1-mile intervals on up o 25 miles. The second cycle is gradu-



ISOMETRIC VIEW

ated at 0.1-mile intervals from 0.1 to 1 mile, and the third cycle is graduated at the same interval from 1 to 10 miles. The left and right indices occupy the positions of the 10-mile graduations.

Tangent-offset *TO* graduation marks are placed by reference to the same table used for the distance scale. However, the tangent-offset scale is shifted to the right until the point 52.8 is opposite the normal position of the left index. Thus it becomes a scale of foot equivalents of miles. Graduation marks are placed at 10-foot intervals from 40 to 1,000 feet and at 100-foot intervals from 1,000 to 10,000 feet.

In addition to the distance scale on the slide, there is a scale of corrections for curvature and refraction *C*. The correction scale graduations are placed from the formula, $D=\sqrt{\frac{C}{0.574}}$, where D is the distance scale graduation opposite which the correction graduation C is placed. For example: To find the point on the distance scale at which the 25-foot correction mark is placed, $D=\sqrt{\frac{25}{0.574}}=6.6$ miles. Graduation marks are placed at 25-foot intervals from 25 to 200 feet and at 50-foot intervals from 200 to 300 feet.

A series of profile elevation scales on the upper limb are in effect a reference table in graphic form. The profile elevation scales are graduated by subtracting the tangent-offset scale values from the elevations of given lookout stations. For example: The 9,000-foot graduation for the Anvil Rock Lookout is found by subtracting 9,000 from 9,590, which places the graduation mark opposite 590 on the tangent-offset scale. Graduation marks are placed at 100-foot intervals on all profile elevation scales.

The slide rule is completed by a large cursor of heavy transparent plastic with "Masonite" runners. A vertical hairline inscribed on the cursor aids in reading the profile elevation scales.

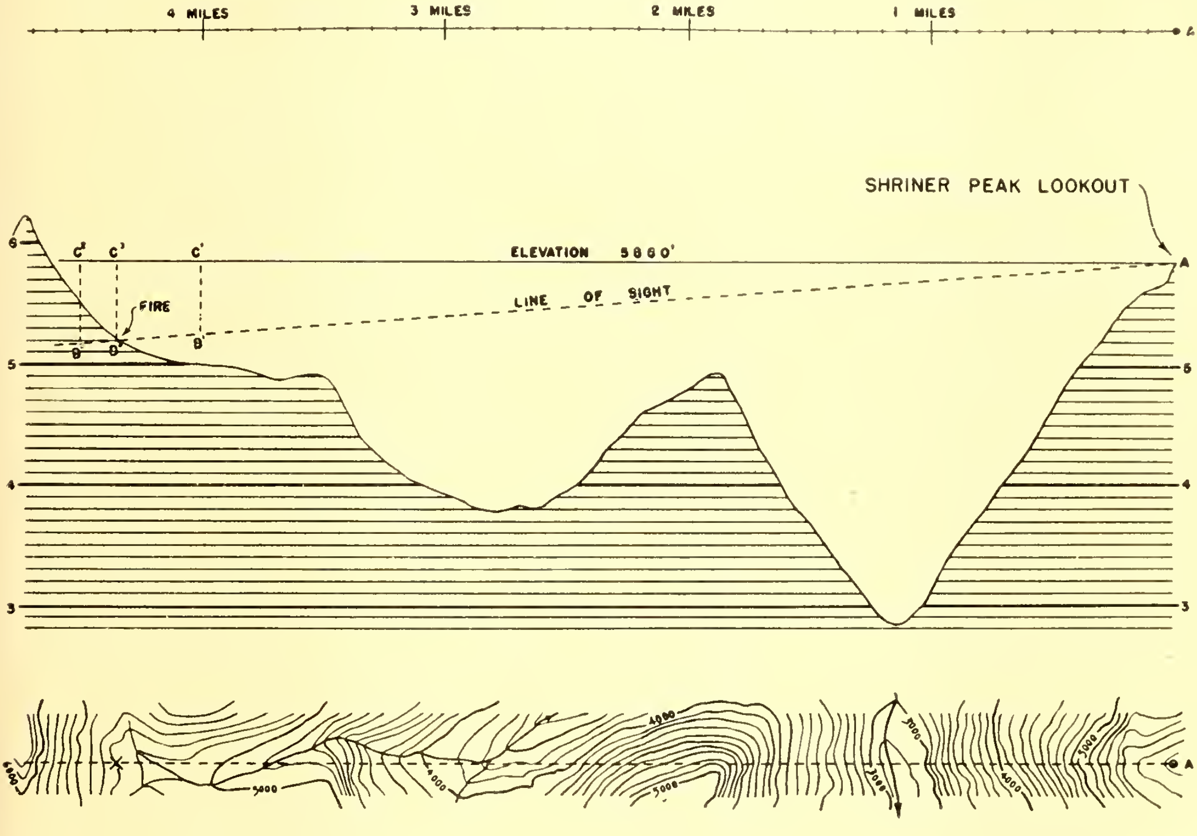
Operation of the Rule

The profiling slide rule determines the location of a fire by a method of approximation based on a trigonometric relationship of simple right triangles, $a=\tan A\times b$. Briefly, the tangent value of the vertical angle is multiplied by the estimated horizontal distance to obtain the tangent-offset or difference in elevation. That value subtracted from, or added to, the height of the lookout station gives the elevation of the point observed with reference to sea level. The elevation thus found is compared with the map elevation at the scaled distance and, if they do not agree, it is apparent at once that the estimated distance is wrong. The estimated distance is then adjusted in a direction which will tend to bring the values into agreement and a new solution is obtained. The second or third approximation will usually locate the point as closely as the topographic map will allow.

A typical problem is worked out below. It is assumed that the fire can be seen from a single lookout station, Shriner Peak. The lookout has given the dispatcher an azimuth, a vertical angle, and an estimated distance. The problem is to determine the position of the fire with the aid of a topographic map.

A tentative elevation is obtained on the profiling slide rule by setting the right-hand index of the slide opposite the vertical angle of −1°38′ and moving the cursor until the hairline lies over the estimated distance of 4 miles. The profile elevation of 5,250 feet is then read from the intersection of the hairline and the Shriner Peak scale. A difference of 250 feet exists between the profile elevation and the map elevation at the same distance, indicating that the estimated distance is not correct.

The profile elevation is higher than the map elevation, so it is necessary to extend the estimated distance to bring the line of sight to ground. A second approximation is therefore made by moving the cursor to 4.5 miles. The new profile elevation of 5,180 feet is lower than the map elevation at the same distance; the estimated distance used is too long. A third aproximation using 4.35 miles gives a profile elevation of 5,200 feet which checks with the map elevation at that distance. The fire is located as closely as possible with the available topographic map.



ALH 2-6-46

The method of approximation used on the profiling slide rule to locate a fire. Vertical angle, −1°38′. First trial: AC^1, 4 miles; C^1B^1, 610 feet; elevation of B^1, 5,250 feet. Second trial: AC^2, 4.5 miles; C^2B^2, 680 feet; elevation of B^2, 5,180 feet. Third trial: AC^3, 4.35 miles; C^3B^3, 660 feet, elevation of B^3, 5,200 feet.

In this case the distance used is not great enough to make the correction for refraction and curvature of the earth necessary. If a distance greater than 5 miles is employed, the correction should be made by mentally adding to the profile elevation the value of the *C* scale graduation lying nearest the hairline of the cursor. In setting the slide for a solution, the right-hand index is ordinarily used for distances of less than 10 miles and the left-hand index for distances over 10 miles.

A check-back should be made on intervening ridges that might cut the line of sight. Otherwise an erroneous location of the fire might be made. In any case where the clearance is slight, a check should be made with the lookout and the vertical angle carefully verified. Check-backs are made rapidly by sliding the cursor to the scaled distance of the ridge and reading the profile elevation against the map elevation. The profiling slide rule will not locate a fire, however, if the base is not directly visible. Such a fire cannot be located by any method of profiling.

Other Uses

In addition to its use for locating fires observed from only one lookout station, the profiling slide rule can be used to check doubtful triangulations. It frequently happens that one fire lookout can see the base of a fire, while another one can see only the smoke rising from behind a ridge or other obstruction. The triangulation may be in error if the smoke drifts for a distance before it becomes visible. This can be detected by employing the profiling slide rule to check the data supplied by the station with direct observation.

The profiling slide rule can also be used for making seen-area maps, either in the field or in the office. In the field the slide rule is used in the manner already described to interpret data obtained with a transit, plane-table alidade, or clinometer. A sheet of grained acetate film base taped over the profile elevation scales can be graduated quickly for both plus and minus angles from the point occupied. Erasures are readily made on such a surface. In the office the operation is changed slightly. The blind area behind a ridge is found by first setting the cursor against the map elevation (less the correction from the *C* scale), and then moving the slide until the scaled distance of the ridge lies under the hairline of the cursor. The vertical angle of the line of sight is thus established, and the solution proceeds by the method of approximation already described until the outer edge of the blind area is found. An experienced operator can complete an accurate seen-area study to a 15-mile radius in an average of 8 hours of working time.

HOW MUCH TIME DOES IT TAKE TO CATCH A FIREBUG?

HENRY SIPE

Assistant Supervisor, Cumberland National Forest, U. S. Forest Service

The question frequently arises: How much time is required to investigate the origin of a fire to determine beyond a reasonable doubt who caused it? It comes up when analyzing the work load of any unit involving fire prevention. It is important when making actual work plans for personnel who are to do the fire prevention jobs.

Fire control men agree that the causes of fires must be known if adequate plans are to be made to prevent future fires. It must be known not only that a "smoker" caused the fire, but *who* was that smoker. Reprimand, payment of damages, or legal action must follow if full prevention value is to be obtained. The amount of time required to establish accountability for fires varies greatly. To secure data based on actual fires, the writer summarized the time spent by rangers and guards in law enforcement on the Cumberland National Forest in Kentucky during 1945. This time-study was carried on while making current diary summaries and checks on all kinds of work performed during the year on four ranger districts. The basic data in man-hours are given in Table 1.

TABLE 1.—*Man-hours spent in law enforcement on 51 fires on the Cumberland National Forest in 1945*

District	Number of fires	Office		Field job		Field travel		Total	
		Year's total	Average per fire	Year's total	Average per fire	Year's total	Average per fire	Year's total	Average per fire
		Man-hours	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
A	12	23	1.9	149	12.4	62	5.2	234	19.5
B	7	5	.7	44	6.3	36	5.1	85	12.1
C	6	4	.7	108	18.0	39	6.5	151	25.2
D	26	48	1.8	13	5.2	46	1.8	228	8.8
Total or average	51	80	1.6	435	8.5	183	3.6	698	13.7

Table 1 includes 32 hours spent in closing out 6 fire cases which originated prior to 1945. These 6 are not included in the number 51 because there is always a carry-over of cases from one year to the next on the Cumberland. In other words, some of 1945's 51 fires will not be investigated and acted on until 1946, or even later.

The question now arises: How effective was the 1945 work? What was accomplished with the expenditure of the time shown in table 1?

Table 2 shows that in 26 out of 51 cases sufficient clues were uncovered either to open legal action for criminal cases, or to request and receive payment of damages. Civil damages were not collected in the 7 criminal cases, nor was criminal action taken in the 19 "damages collected" cases. Five of the 7 criminal cases were won and 2 lost. It will be noted that there is not a clear relation between the amount of time spent by districts as compared with the number of cases initiated (criminal plus damages). Various factors affect this lack of relationship, such as causes, groupings, ability and thoroughness of individual investigators, press of other work, and plain luck. For example, table 3 shows that smokers were responsible for most of District A's fires—very tough cases to solve. Nearly one-fourth of District D's fires were caused by railroads, which on this forest require little time to investigate; damages were collected on all of them. All personnel were operating under the same policies and instructions, but the writer could discern these variable factors in action.

TABLE 2.—*Results of law enforcement work on 51 fires on the Cumberland National Forest in 1945*

District	Actionable fires	Criminal cases initiated	Damages collected out of court
	Number	*Number*	*Number*
A	12	1	2
B	7	3	1
C	6	1	4
D	26	2	12
Total	51	7	19

Table 3 shows the causes listed on the fire reports. Most of the miscellaneous fires were caused by persons smoking bees or game out of trees or by children playing with matches. A comparison of tables 2 and 3 reveals that the number of smoker and incendiary fires equals approximately the number of cases on which action was not taken; actually cases on nearly all of these fires could not be initiated because of lack of evidence.

TABLE 3.—*Causes of 51 fires on the Cumberland National Forest in 1945*

District	Railroads	Lumbering	Campfires	Smokers	Debris burning	Incendiary	Miscellaneous	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
A				8			4	12
B				3	2	2		7
C	1	1		2	1	1		6
D	6		4	4	1	6	5	26
Total	7	1	4	17	4	9	9	51

Before drawing conclusions concerning the time needed for law enforcement, a number of other factors must be examined. All of the following factors affect the amount of time required to process cases:

1. As mentioned before, most of the time used was spent on the easiest fires to solve. There was not adequate time for investigations because of the press of nonfire work or fire work other than law enforcement.

2. All the criminal cases in the study were brought into county courts; not one went into Federal Court or State Circuit Court. Thus, the long hours necessary to write up and prosecute cases in higher courts were not expended. Some cases should undoubtedly have gone

into these higher courts. In many of the county court cases the defendant voluntarily pled guilty before the county judge or a magistrate.

3. Two men working together will often get better results, but will increase the hours per case. In many of the fires on the Cumberland National Forest only one investigator was used because of lack of time, personnel, etc. In only one or two fires were there more than two investigators.

4. Often the investigator was also the fire boss and could not devote full time to law enforcement. This meant that some travel was charged to suppression.

5. A certain amount of dislike for this kind of work cuts down the time spent.

6. Supervisor and staff time above ranger grade was essential in processing the 51 cases, but is not included in the tables.

7. Some time actually used was probably not entered in diaries from which the statistics were taken. However, most of the men who investigated the fires were contacted personally by the writer with regard to such omissions.

8. In computing a yearly load for a unit, time must be added for investigating false alarms and nonreportable and nonactionable fires, none of which were included in this study. The writer has investigated and prosecuted nonreportable cases that required as much time as reportable ones.

Summary and Conclusions

A summary of these data shows that on the Cumberland National Forest in 1945, rangers and guards spent 13.7 hours per fire to investigate 51 fires and to prosecute or settle 26 of them. Even then, not one true "firebug"—a malicious incendiary—was caught! Eight and five-tenths hours of the 13.7 were spent on actual field work.

The frequency rate for reportable fires dropped below 10 per 100,000 acres protected in 1943, 1944, and 1945. Only in 1945 did the area burned drop below one tenth of 1 percent. As of May 15, 1946, there has been an increase in fires and the number may again go above 10 per 100,000 acres. However, the effect of law enforcement work on reduction in the number of fires is subject to factors not described in this article and must be treated separately.

It is safe to conclude, however, that if every man-caused fire is to be thoroughly investigated, more than 13.7 hours per case must be devoted to the job. Just how much more time will be needed must be determined by further study. Records show that 30 to 50 hours are required to investigate the more difficult individual cases; cases in Federal Court take even more time. The writer's observation is that the 13.7 hours should be doubled at least.

Perhaps more important than attempting to fix a certain number of hours as necessary for the investigation of a fire case is the need for administrators to recognize that *more time* must be allocated to law enforcement activities. When it is realized that some units—as large as States—are "initiating" only one-tenth of their actionable fires, a revision of priorities appears to be in order.

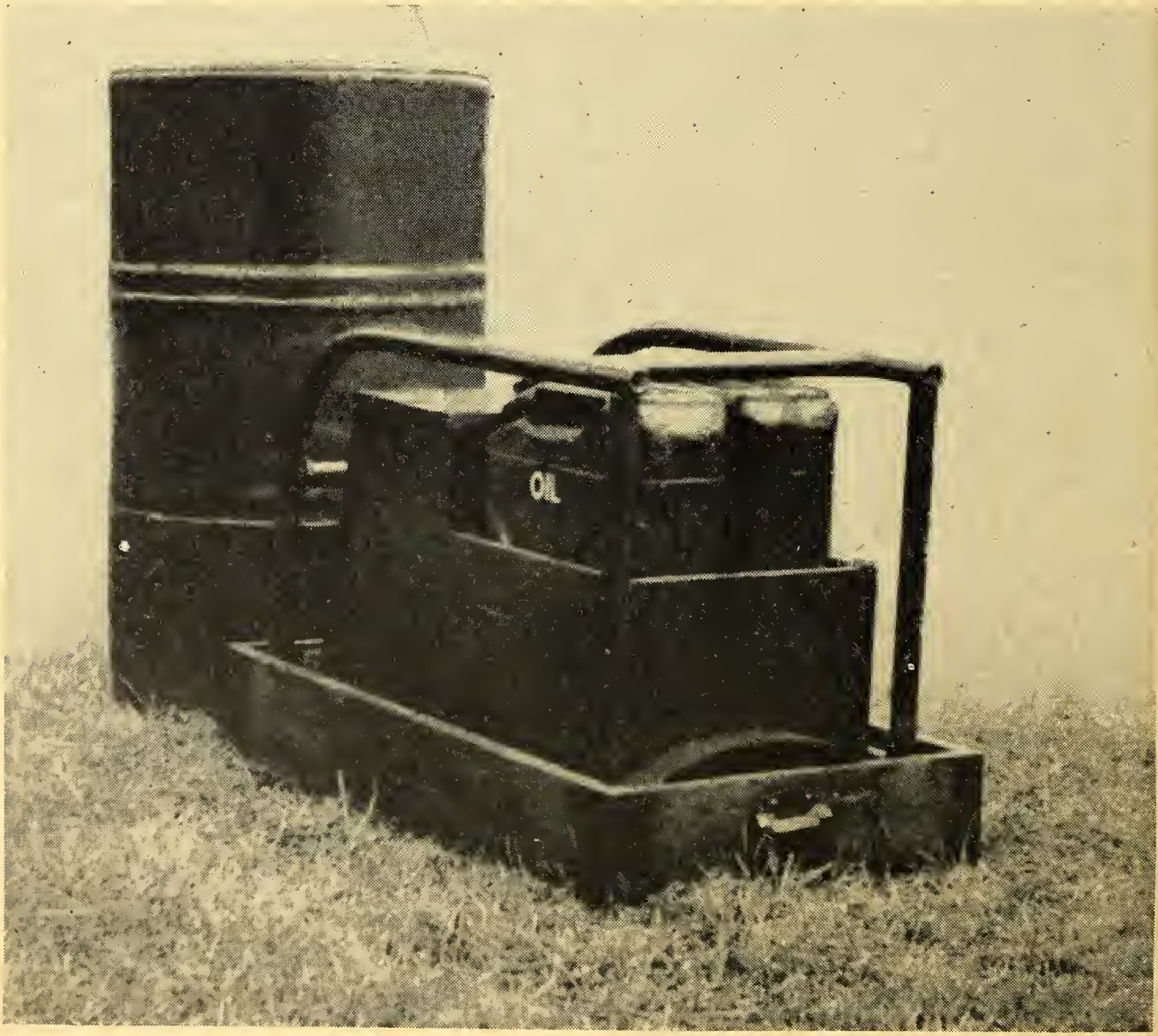
FOREST-FIRE GASOLINE AND OIL KIT

Fred G. Ames

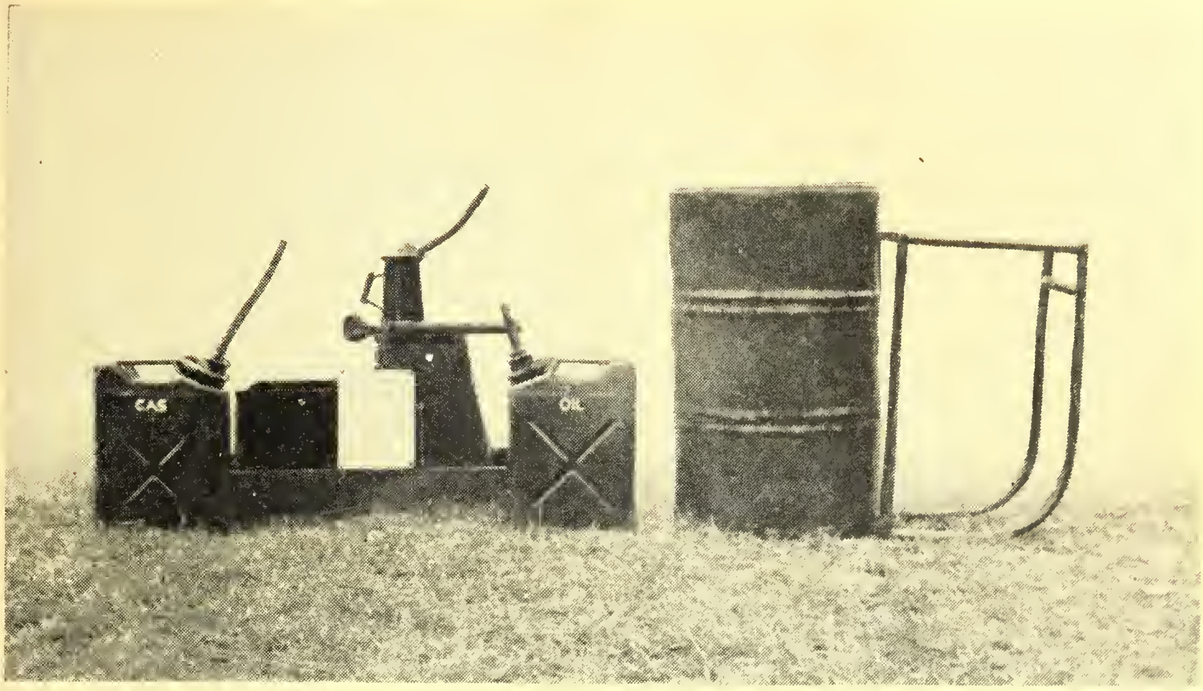
Ranger, Ocala National Forest, U. S. Forest Service

All the items necessary for transporting gasoline and oil to going fires and transferring clean oil and gas to equipment on the fire line are contained in a kit devised by the writer for the Ocala National Forest.

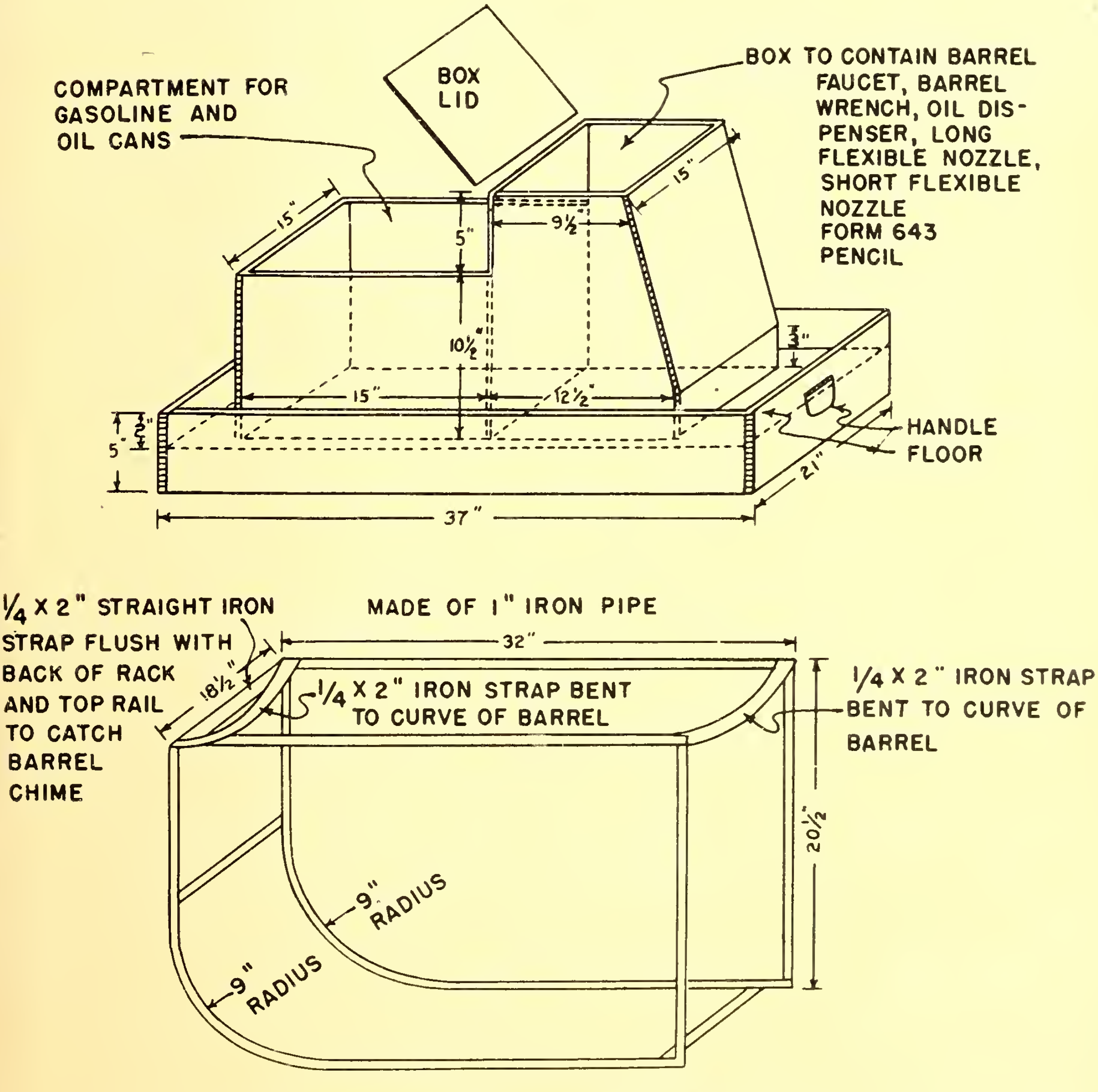
The unit is packed in two parts for transportation: (1) a steel barrel, and (2) cans, barrel jack, and accessories carrier. Two standard 5-gallon Army gasoline cans (U. S. W42, Monark or Nesco, 13 inches wide × 6½ inches thick) are used for the gasoline and lubricating oil, and are packed in the open compartment of the carrier. The use of Army type gasoline cans makes packing very simple. The closed compartment contains a barrel faucet, combination wrench, oil dispenser, one flexible nozzle for the gasoline can, one short nozzle for the lubricating oil can, Form 643 (gas and oil issue sheet), and a pencil. The barrel jack is inverted and placed down over the open



Complete servicing unit packed in two parts for transportation to fire line.



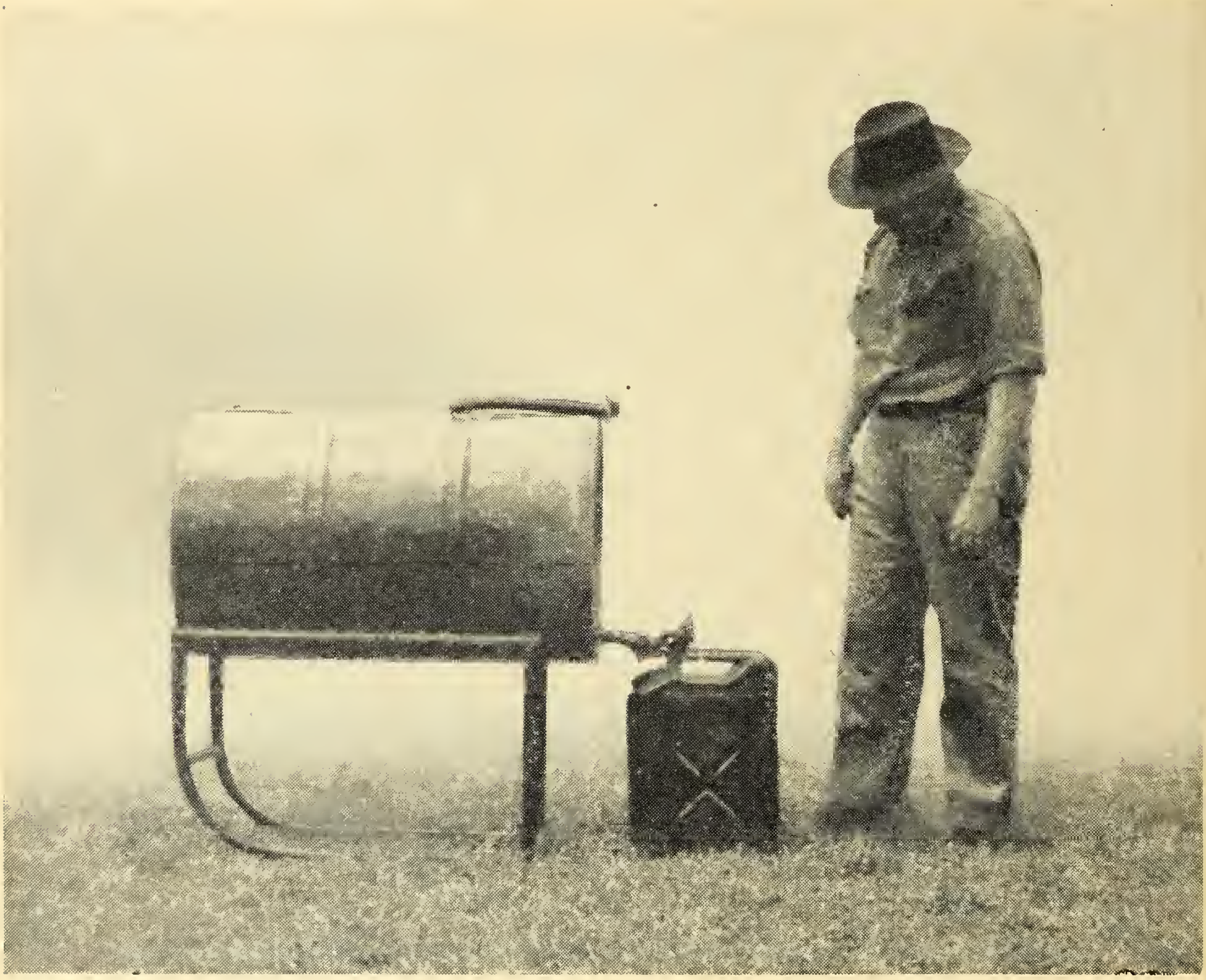
Servicing outfit disassembled to show individual items.


BOX LID
COMPARTMENT FOR GASOLINE AND OIL CANS
BOX TO CONTAIN BARREL FAUCET, BARREL WRENCH, OIL DISPENSER, LONG FLEXIBLE NOZZLE, SHORT FLEXIBLE NOZZLE FORM 643 PENCIL
15"
15"
5"
9½"
10½"
15"
12½"
3"
¾"
5"
HANDLE
FLOOR
21"
37"
¼ X 2" STRAIGHT IRON STRAP FLUSH WITH BACK OF RACK AND TOP RAIL TO CATCH BARREL CHIME
MADE OF 1" IRON PIPE
32"
18½"
¼ X 2" IRON STRAP BENT TO CURVE OF BARREL
¼ X 2" IRON STRAP BENT TO CURVE OF BARREL
20½"
9" RADIUS
9" RADIUS

Plan for constructing gasoline and oil kit.

and closed compartments of the carrier and rests in the space between the compartments and the sides of the carrier.

To use the barrel jack, stand the barrel on end and screw in the faucet. Place the barrel jack on end and slip the iron strap on the rear end of the jack under the edge of the barrel (chime), pull the top of the barrel forward until it and the jack are in a horizontal position. The curved runners of the jack serve as a fulcrum.

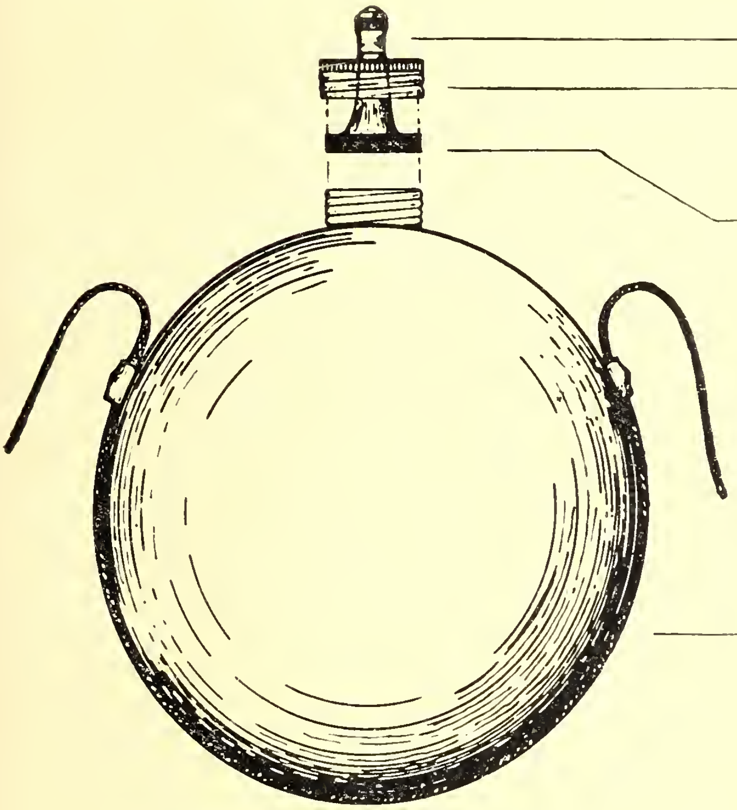


Gasoline being transferred to Army-type safety can.

METHOD FOR REPAIR OF CANTEENS

Dean M. Earl

Forest Ranger, Apache National Forest



Valve stem cut from discarded tube.

Canteen cap - drill $\frac{1}{2}$" hole or size to accommodate valve stem. Discard original gasket in canteen cap.

Cut base of valve stem to form gasket fitting snugly in canteen cap.

One gallon standard canteen, canvas or cloth covered.

Purpose: To restore capacity of dented and crushed canteens. To locate leaks for resoldering.

Method: Restore shape and capacity

Prepare a new or good canteen cap as above. Screw snugly onto canteen. Apply air pressure from foot pump or air line. When pressure forces sides back to approximate original shape tap with light hammer to remove irregularities. This can be done without removing cover.

Leaks

Remove cover. Apply light pressure. Place in tub of water. Mark leaks and resolder. Replace cover.

HOT FOOD FOR FIRE FIGHTERS

R. H. Williams

Supply and Transportation Officer, Los Angeles County Department of Forester and Fire Warden

One of the toughest problems encountered in fighting brush and forest fires is the provision of adequate food for fire fighters. The difficulties are varied, depending on the size of the fire and the nature of the terrain. On large fires, personnel are frequently located on sectors remote from the base camp. This increases the responsibilities and problems of the supply officer.

We all realize that fire fighting is an exhausting physical activity. Yet very little progress has been made in improving the physical comfort of the fire fighter. Our fire-fighting facilities have been built up by the development and acquisition of the latest types of equipment, and rightly so. However, we are still largely dependent on manpower; and the best tool in the world is only as good as the operator. Therefore, it is imperative to provide good physical conditions and comforts for our fire fighters.

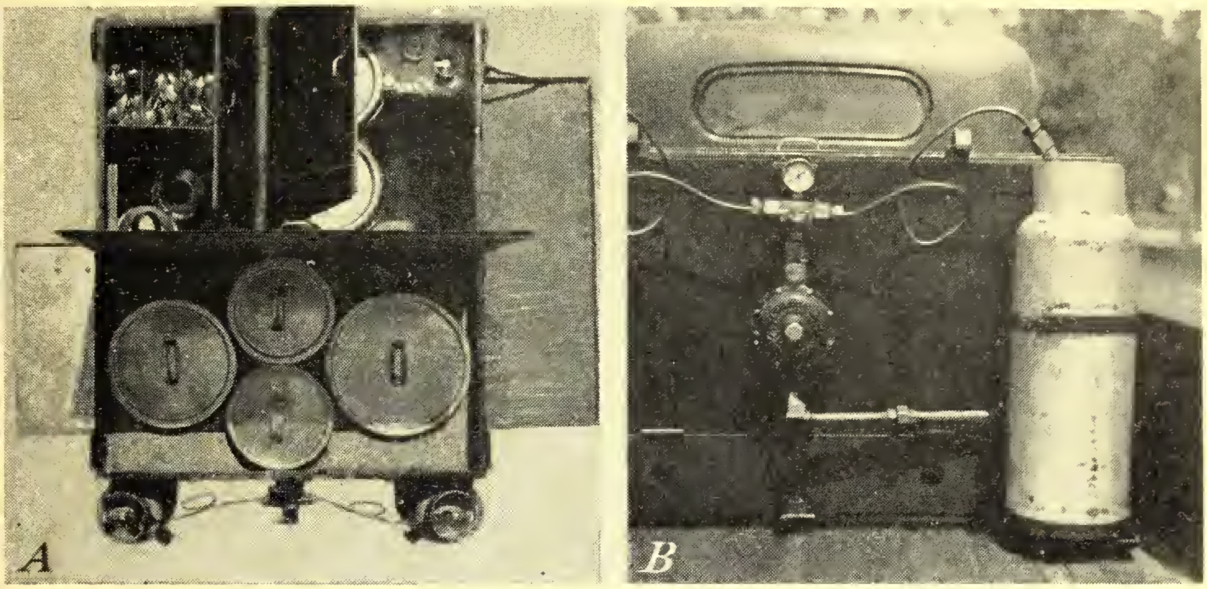
The feeding of personnel on fire-line duty has largely been a secondary consideration. In most cases fire fighters receive little or nothing to eat between the times of departure from and return to the fire camp. To alleviate this condition this department has taken steps to provide hot, nourishing meals to all personnel while on actual fire-line duty.

Portable Army field mess units and the Red Cross doughnut wagons were studied for possible adaptation to this purpose. After much thought and consideration it was decided that a portable unit, based on the steam-table principle, would be the most practicable. This unit was to be a skid type and of a size easy to handle and use on a half-ton pick-up truck. It was also to be capable of carrying food and the necessary equipment for serving approximately 100 men. All food would be prepared at the main camp. Our first construction problem was getting the necessary galvanized sheet iron, which at the time was practically nonexistent on the market. However, with the little material we had on hand, plus the results of a diligent search of used-stock piles, sufficient supplies were assembled for the job. Frank C. Barnes, the department's fire equipment repairman, was assigned to work out a unit based on the steam-table principle.

Some idea of its construction and lay-out may be obtained from the accompanying pictures. The writer will be glad to send interested persons prints showing details of construction of the unit.

One-half of the unit consists of a hot food compartment. This section is double-walled and interlined with ½-inch asbestos sheeting. It contains four stock pots—two 3-gallon, one 6-gallon, and one 9-

gallon. These pots are submerged to about two-thirds of their depth in a chamber containing approximately 22 gallons of water. This chamber is provided with a splash plate and several baffle plates to prevent surge. Actual practice has shown that better results are obtained when the chamber is filled with hot water. The water is maintained at a proper temperature by three gas burners supplied with fuel from two 9-pound cylinders of propane gas. The other half of the unit is divided into two compartments. One, insulated with Compo Board, contains two 3-gallon stock pots for juices; the rest of this compartment is used for storing bread, sugar, salt, etc. The other compartment carries necessary utensils: cups, forks, knives, spoons, etc. All compartments are equipped with night lights connected with the truck electrical system. The over-all dimensions of this unit are: width, 40 inches; length, 48 inches; and depth, 24 inches. The unladen weight is approximately 400 pounds.



Portable mess unit: *A*, view from above showing utensil and cold food compartment, hot food compartment, and the two cylinders of propane gas; *B*, end view showing equipment for maintaining proper temperature of water in hot food compartment.

We have used this unit on several fires with most satisfactory results. In fact, we believe so sincerely that this type of unit will have a very definite place in our future program that we plan to construct another one for use during the coming fire season.

THE F. B. I. COOPERATES WITH THE FOREST SERVICE IN FIRE PREVENTION

B. F. Seizert

District Ranger, Talladega District, Alabama National Forest

In accordance with an understanding reached during the winter of 1945–46, the F. B. I. is increasing its cooperation with the Forest Service in fire prevention and law enforcement. Ranger B. F. Seizert of the Talladega District, Alabama National Forest, reports on action taken by the F. B. I. at the request of the Forest Service. While the action did not result in immediate trials and convictions, it is expected that some will follow. The real test of its value, however, will be the answer to the question, "How much fire prevention did the action buy?" In this respect the report is encouraging.

Since the establishment of national forests in Alabama, the Talladega Ranger District of the Alabama National Forest has had more fires annually than any other ranger district in the State. Sixty percent of the fires have occurred in the south half of the district, which coincides in a general way with a section which has had more incendiary fires than any other spot in Alabama. Division of the Talladega District into two parts in October 1945 still left the old "hot spots" in the south district. But, at the same time, it made possible concentration on fire prevention and law enforcement in those communities where fire occurrence had been high.

During the war the number of fires on the Talladega Destrict decreased. Many forest residents left to work in war plants, and there was less use of the forest by hunters. At the close of the war, however, use of the national forest and adjoining areas increased noticeably. Former forest residents returned to their homes, and the application for hunting permits was large. It was natural to fear a marked increase in fires in 1946.

From January 1 to February 20, 1946, 20 fires occurred, 5 of which were definitely of incendiary origin. On February 20, Assistant Supervisor Swarthout and the district ranger called at the Birmingham office of the Federal Bureau of Investigation and discussed the fire situation on the Talladega District with Mr. Roby, Assistant Special Agent in Charge.

Late in the afternoon of February 21, five incendiary sets occurred along a main highway. Assistance was requested from the F. B. I., and within a short time Special Agents Slate and Southworth arrived at district headquarters. The agents were made familiar with the fire history of the district and then, with the ranger, began an investigation of the fires. On the following day while these fires were still being investigated, three more incendiary sets occurred in the same vicinity on the opposite side of the highway. The F. B. I.

agents immediately set up a road block. A large number of persons were interviewed and the people generally became aware that the F. B. I. was trying to find out who was responsible for fires set on national forest lands. Later the agent and the district ranger enlisted the cooperation of local law enforcement officers and made plans for road blocks and other assistance. The agents continued their investigation of the fires and their interviews with local people throughout the week.

The agents were most cooperative and helpful, and the ranger working with them learned new angles of investigative and law enforcement work. Through their contacts with local individuals, the agents were able also to pass on to the district ranger some good leads for future fire prevention work. These ideas were used later in spot announcements and broadcasts from the local radio station. Up to this time no more fires have occurred along this highway.

On March 1, following a number of incendiary fires, the district ranger again called on the F. B. I. for assistance. This time the fire was in a community where it has been the usual thing for incendiary fires to burn off a large area each year. Special Agent Slate investigated the fire the next day, and key individuals and suspects in the area were contacted. Since this investigation by the F. B. I. agent, neither incendiary nor any other fires have occurred in this immediate vicinity.

Fifty-seven man-caused fires occurred on the Talladega District between January 1 and April 29, 1946. Twenty of these fires were definitely of incendiary origin. Since March 14, however, there have been no incendiary fires on the area.

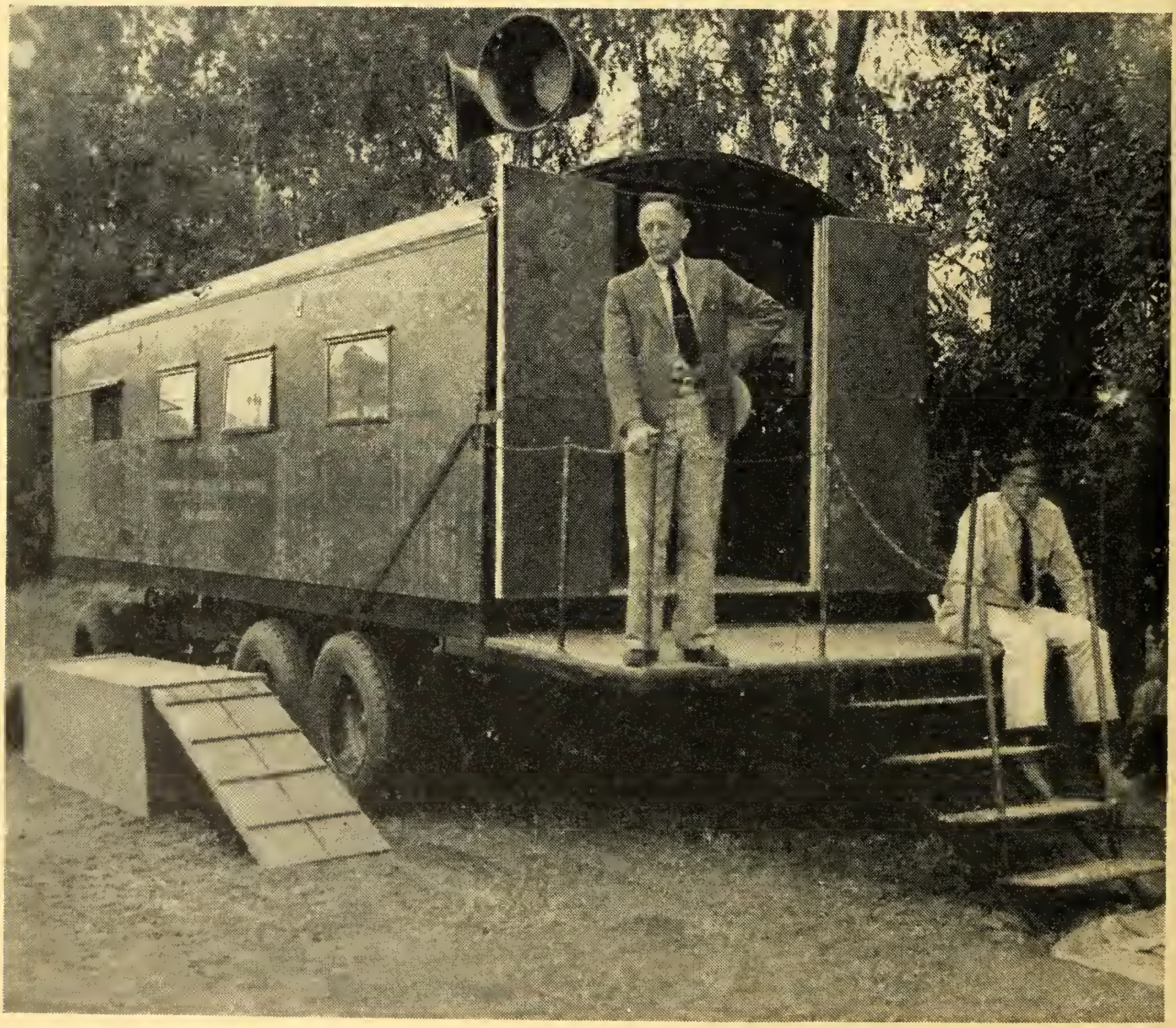
From April 17 to 19, F. B. I. Agent Hartley and the district ranger conducted a joint crime and fire prevention campaign at 14 schools in and near the Talladega Ranger District. A total of 3,225 students and teachers were reached. One of the subjects discussed was the jurisdiction of the Federal Bureau of Investigation over national forest lands. The campaign resulted in increased interest in the work of both the Federal Bureau of Investigation and the Forest Service. It was a "trial run," but judging from the interest displayed by both students and teachers it was very successful. Tentative plans have been made for another cooperative tour of the same kind at the beginning of the school year in the fall of 1946.

FIRE-CAMP TRAILER

Leslie S. Percey

Forestry Construction Superintendent, Los Angeles County Department of Forester and Fire Warden

During the past 25 years, the Los Angeles County Department of Forester and Fire Warden has been active in the development of equipment and methods to cope more effectively with the ever-present fire problem. These efforts have not been confined to fire-fighting equipment alone, but have been applied to the improvement of all phases of fire operations. The development of an efficient fire camp set-up has not been overlooked. Perhaps the facility usually given the least attention is the fire-camp operations office. Not so many years ago, it was considered that a few packing boxes or shipping cases would suffice. Later, a tent was added. Both were crude and

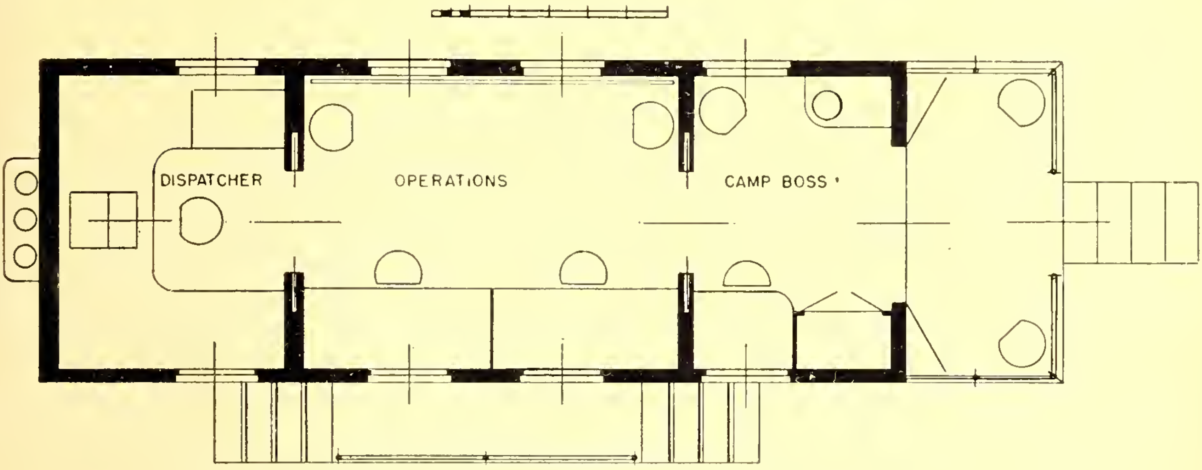


Chief Fire Warden addressing fire school from folding platform at rear of fire-camp trailer office.

afforded little or no protection from wind, dust, and cold nights, and the clerical work of the fire camp reflected the lack of equipment planning.

Then came the Civilian Conservation Corps and similar programs, effecting the construction of a transportation network of fire motorways and truck trails, which wrote finis to the reliance on pack trains to supply fire camps on fires in territory under the jurisdiction of this department. When two-way radio was installed in all fire apparatus, it became apparent that an improved fire-camp field office was essential to efficiently handle dispatching and clerical work under all climatic conditions.

At this point, Chief Spence D. Turner directed the Department's construction division to design and construct a fire-camp trailer—an office on wheels to accommodate the fire-camp boss and house the dispatcher, timekeeper, and clerical force. The author held several conferences with fire-camp dispatchers, timekeepers, and fieldmen usually assigned to the fire camp to obtain their ideas and recommendations. On this basis, the fire-camp trailer was developed.



Floor plan of fire-camp trailer office.

Since funds were limited, it was necessary to start with a large cargo trailer made available by another department. On this was constructed a three-room office with insulated exterior walls, ceiling, and floor, and insulated partitions with sliding doors.

The forward compartment is designed as a communications office, in which is installed the PBX switchboard, teletype, two-way radio, and public address system. The middle section is constructed with built-in desks, drawers and cabinets for forms and stationery, maps, and dispatcher's operations board. The rear compartment is the office of the fire-camp boss. All offices are lighted with electricity, heated by butane wall heaters, ventilated with electric fans, and interconnected by telephone. Since many of the worst fires in Southern California occur in the fall months, the heating arrangement is very much appreciated by those assigned to fire-camp office operations. The fire-camp trailer is a proven success and provides a complete field office for maximum operating efficiency in dealing with fires and major disasters in any kind of weather.

FOREST FIRE FIGHTING EQUIPMENT DEMONSTRATION

Division of State Cooperative Fire Control—Washington Office, U. S. Forest Service

Michigan, Wisconsin, and Minnesota were hosts to a group of 73 State and Federal forest fire control men from U. S. Forest Service Regions 7, 8, and 9, from June 10 through 15 of the present year. The purpose of the meeting was to afford an exchange of ideas on fire-fighting equipment, stimulated by field showings of special types of equipment. The 6-day field demonstration was arranged by the Lake States.

Interest was widespread. Fifty-nine State men, who came from Texas, Georgia, and Connecticut, and many of the other States between these widely separated points and the Lake States, were in attendance for the full week.

The group assembled at the Higgins Lake Training School, operated by Michigan's Department of Conservation as a year-round training center for departmental personnel.

Michigan's demonstration ran from noon of June 10 until noon, June 13. Briefly, it included an inspection of forest fire control improvements, such as a regional and district office set-up, a fire equipment shed, the Roscommon fire equipment experiment station, radio laboratory, a remote control radio station, a typical fire tower, and fire prevention practices in an oil field. One day was devoted to a field demonstration of Michigan's mechanical fire-fighting equipment. Enough models were on hand to show the steps in the development of some types of equipment. Michigan featured new plowing units, the sand-throwing trencher, pumping units, backfiring torches, and well-sinking units employing water pressure for drilling. Equipment was shown and demonstrated in a large abandoned field, surrounded by woods. This provided opportunity for showing performance on both open and forested land. Announcements and comments regarding equipment while in operation were made over loud speakers mounted on a sound truck. (This feature added much to the clarity and speed of running the demonstration.)

En route to Wisconsin short stops were made at old burned areas, the Central Repair and Sign Shop at Gaylord, and the Escanaba District Headquarters. A field demonstration of building fire lines with a bulldozer in a heavy slash and blowdown area was also seen.

Wisconsin fieldmen took over at Norway, Mich., near the State line. On the way to Eagle River, stops were made at a typical Wisconsin State ranger station, a lookout tower, and the plant of the Goodman Lumber Co.

The Wisconsin Conservation Department arranged with the "Trees for Tomorrow" organization to house and feed the group at its Eagle River Conservation Training Camp leased from the United States

Forest Service. Both here and at Higgins Lake, accomodations and food were excellent.

The demonstration of Wisconsin's fire-fighting equipment was held in a natural amphitheatre, with a truck trail running on a contour along the foot of the slope. The audience sat on the ground or in an improvised bleacher on the slope of the hill. Each piece to be demonstrated was brought in along the truck trail from around the hill, unloaded, and put to work in the valley where everyone could see it. This demonstration covered tilting bed trailers, the chain saw, and various types of plowing and pumper units. Here also, announcements were made from a sound truck. Following the demonstration, equipment was parked conveniently for inspection.

On the way to Tomahawk a stop was made for a demonstration of Wisconsin's new seedling planting machine.

At Tomahawk, Wis., the men were shown through the State's forest protection headquarters, central warehouse, and shops. Also, Minnesota personnel demonstrated some of their portable and semiportable water-pumping equipment here. This wound up the demonstrations. Because of lack of time and since much of Minnesota's heavy equipment is similar to that of Wisconsin, it was considered unnecessary to transport the heavier pieces to Wisconsin for display or demonstration.

The week of demonstrations and the swapping of ideas and experiences was exceptionally worth while. Many of the men expressed the hope that other intersectional fire equipment meetings would follow. The Lake States have set a very high standard as hosts and as efficient builders and demonstrators of equipment. They are to be congratulated on staging a show which will prove highly beneficial to those who attended.

A CONVERTED MILK TRUCK MAKES A HOT-FOOD DISPENSER

K. E. Klinger

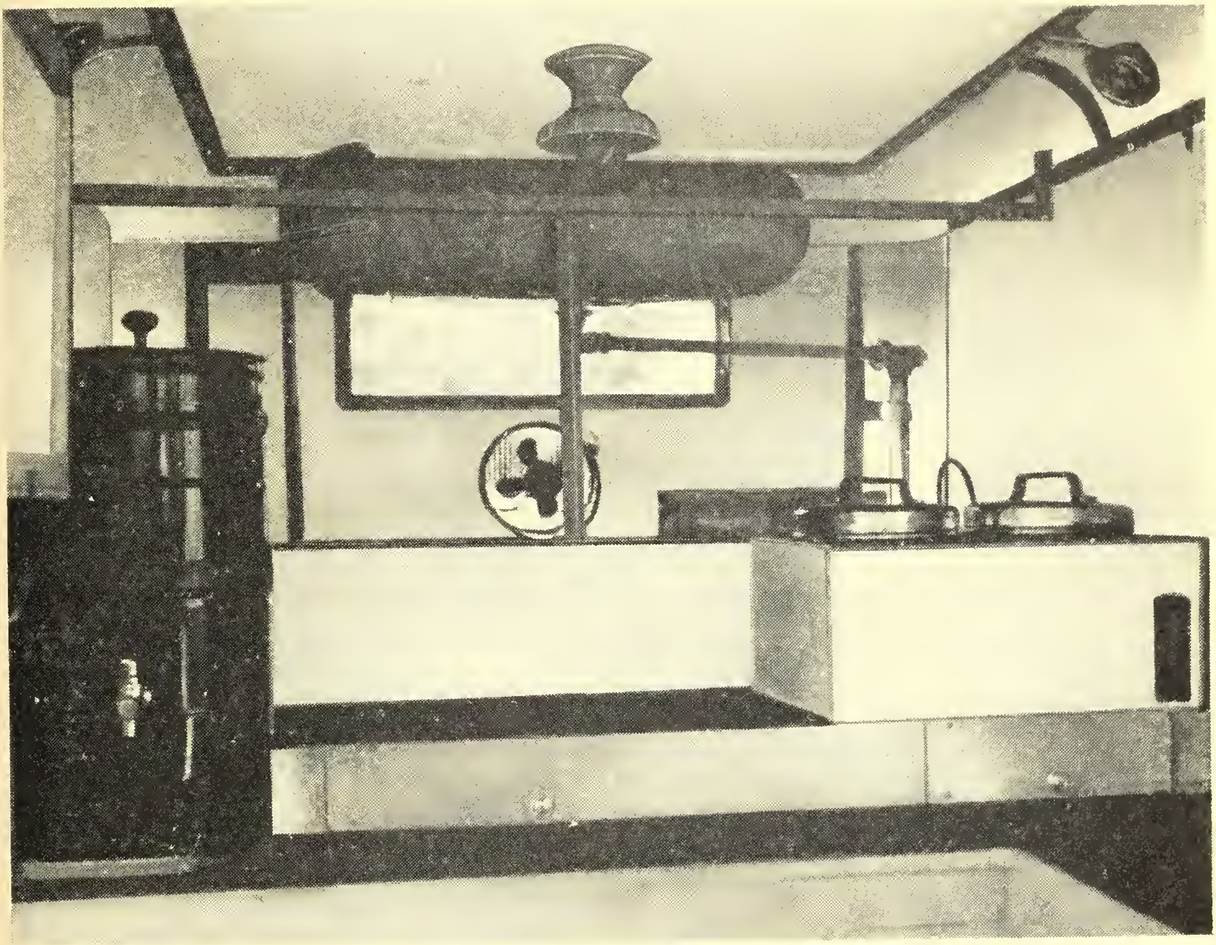
Battalion Chief, Los Angeles County Fire Department

It has been recognized for years that fire fighters on prolonged fire duty miss many meals, which results in lowered efficiency. In the fall of 1944, the members of Battalion 2, Los Angeles County Fire Department decided to do something about it. They were tired of eating cold sandwiches and drinking lukewarm coffee while fighting stubborn fires. Each member donating toward the cost, they purchased a 1936 four-cylinder Stutz package car, formerly used as a milk truck. The men steam-cleaned the truck, overhauled the motor and chassis, repainted the body inside and out, and fitted it up for a kitchen.

A steam table was built from old boiler plate and ice cream containers, and a hot plate and two-burner gas plate, made from old stove parts from junk yards, were installed. Fuel enough for several

Traveling commissary.

days' continuous use was supplied from a butane tank. A 6-gallon butane coffee urn was donated and installed, and a 22-gallon water tank gravity flow connected to a faucet and sink supplied water for cooking and dishwashing. Other equipment included was a 25-pound capacity ice box, an electric fan for ventilation, a lighting system for 110 volts from Home-lite generator or domestic outlets, and a supplemental 6-volt lighting system. The truck has all the conveniences of an up-to-date kitchen and ample room for storage of food and dishes. The outside of the truck body carries brackets to which detachable counters can be fastened for serving purposes.



Interior of traveling commissary showing coffee urn, hot-food dispenser, steam table, and grill.

This commissary unit was rebuilt and financed entirely by members of battalion 2. They presented it to the Department for use in battalion 2 area, and the County Board of Supervisors accepted it with thanks.

BUILDING A COOPERATIVE TANKER

A. G. Randall

District Ranger, Harney National Forest

The Volunteer Fire Department of Hot Springs, in the Black Hills of South Dakota, is now using a forest fire tank truck which shows what can be done with a limited amount of money. Building the tanker was a joint undertaking of the fire department and the Harney National Forest.

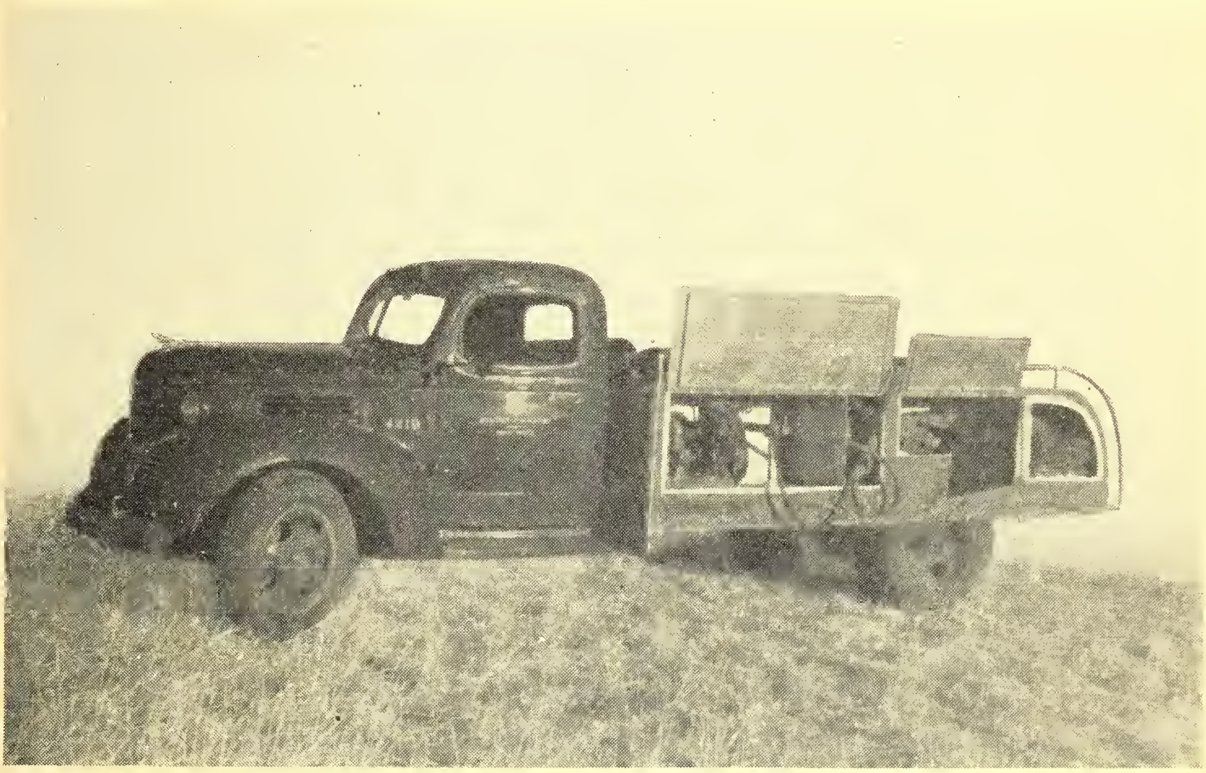
The department, founded in 1890, not only has done a good job taking care of the city of Hot Springs, but also has fought both farm and range fires in the surrounding country. In 1938, land west of Hot Springs was added to the Harney Forest so that grass and timber cover on a vital watershed might have better protection from fire. It was natural that the Hot Springs fire department and the Forest Service should work together.

In October 1944, the Forest Service made available a Dodge ton-and-a-half truck chassis and a Bingham Type Z portable pumper. The Hot Springs fire department undertook to build a tanker body as streamlined and efficient as its other equipment, which includes a powerful modern pumper; booster tank-pumper; a well-equipped hook, ladder, and salvage truck; a pick-up-mounted smoke extractor designed and built by the department; and an iron lung.

Materials were obtained at little or no cost from various sources. Steel, consisting mostly of ¼-inch bridge tread material, came chiefly from Fall River County. The department employed one of its members, an experienced welder. Other members helped cut the steel in their spare time. Chief Victor C. Englebert did most of the designing and led in carrying on the work.

The central part of the body is a rectangular steel tank, 3 x 2 x 9½ feet, holding slightly more than 400 gallons of water. It is fitted with three bulkheads to prevent surge and is coated inside with anti-rust compound. The bottom is supported by 2-inch planking, resting on the truck frame and held in place by flanges. On either side, cabinets were constructed with tops and bottoms flush with the tank, except that the bottoms over the hind wheels were necessarily raised. The cabinets were made 24 inches wide to give the whole body the width of a standard truck platform. The body has perpendicular sides and a flat deck. The rear is rounded to give a streamlined appearance. The sides are dropped 7 inches and have hinged sections, which may be raised to change tires. The cabinets are framed with ⅛-inch steel and the covers with ½-inch angle iron.

The body is welded throughout to form a solid unit, which is fastened to the truck frame by means of four U-bolts. It can be changed readily from one chassis to another. The edges of the body have a bead of ½-inch pipe, and the deck is surmounted by a railing of 1-inch pipe at a height of 6 inches. Steps are provided in the rear, making it possible to carry extra men. The sides are painted red and the deck, aluminum. The green cab has been retained. The colors give the truck a pleasing appearance. The side sections covering the cabinets are hinged at the top. They are held shut by slide bolt fasteners and may be held up by wing nuts which fasten them to the railing. The cabinets are painted aluminum inside and are provided with outlet boxes for lights. The truck carries an electric siren. The fire department spent some $450 of its funds but now operates a unit which it estimates would cost $1,500 if purchased from a manufacturer. This estimate does not include the chassis and equipment furnished by the Forest Service.



Hot Springs tanker with cabinets open, showing Bingham pump in first compartment, pump accessories in second, and hand tools in tail section. Hoses are shown attached at the pump. Reels have been installed since this picture was taken.

The Bingham pump is mounted in the front left-hand cabinet. Its fuel tank is on top of the deck, immediately behind the cab. Pipes and valves are so arranged that water can be pumped into the tank from a suction hose or under pressure to 1½ or ¾-inch outlets. A by-pass is provided so pressure can be regulated. Back-pack pumps can be filled from the tank by gravity. There is a filling dome on top of the tank so that any source of water can be used. The department prefers an independent pump motor to a power take-off from the truck motor, because pump pressure can be maintained while the speed of the truck is varied as needed.

The unit has two ¾-inch rubber hoses mounted on live reels. "Stayput" hose couplings keep the pressure from forcing the hose off the connections. Instead of conventional nozzles, the hoses have been fitted with adjustable shower heads, mounted on pipes 6 feet long for convenient handling. To avoid wasting water or stopping the pump, these can be thrust temporarily into the top dome. In this vicinity, fuels are generally light. Therefore, use of the ¾-inch hoses gives adequate wetting, and 2 to 3 miles of fire edge in grass can be controlled with one load of water. The shower heads can be adjusted to give a very fine spray, approaching a fog. This had a powerful extinguishing effect, even when tried experimentally on an oil fire. Nozzle operators may either ride on the truck or walk alongside. One or two men with shovels should follow the truck, since it is possible to miss small spots which may flare up, particularly if the truck is moving fairly fast and the nozzle men are riding. Actually, no trouble has been experienced so far from the survival of small spots, the wetting apparently being sufficient to extinguish fire in grass completely. Fire is quickly knocked down in fuels such as dry sweet clover, where flames often leap 10 feet in the air. In this type, the truck travels more slowly than in grass. The truck also carries 1,000 feet of 1½-inch linen hose. The main use of this hose is expected to be on fires which the truck cannot approach directly because of rimrock, etc. The 1,000 feet of hose may either reach the fire or materially shorten the distance to fill back-pack cans. Of course, many uses may be found for an extra 1½-inch line on both rural and urban fires.

In addition to the equipment already mentioned, the truck carries in the cabinets 5 back-pack pumps, 3 Pulaskis, 4 McLeods, 3 axes, 3 picks, 27 shovels, tarpaulin, first-aid chest, and bolt-cutters for getting through wire fences. Both Forest Service and State tools are included. Although the tools do not make a balanced unit, the truck is ready for almost any situation.

The truck is kept in the fire station with the other equipment, ready to go at all times. Since grass fires may occur in below freezing weather, storage in a heated garage is particularly valuable.

The operation and use of the truck is covered by a cooperative agreement between the Forest Service and the Volunteer Fire Department. The agreement also provides that equipment furnished by each agency shall remain its own property. The pooled equipment is providing, in the southern Black Hills, a highly valuable fire control unit with which both parties are highly pleased.

THE LOUISIANA FIRE JEEP

Louisiana Forestry Commission, Baton Rouge, La.

From the earliest use of the jeep by the Army, the fire control men of the Louisiana Forestry Commission were interested in it. They watched thousands of jeeps brought into army training centers in Louisiana and saw them swarm along the highways and through the woods, traveling through seemingly impassable areas. In July 1944, the report of Maj. A. C. Rowland on "Development of Forest Fire Fighting Equipment,"[1] issued by the Forestry Branch of the Army Air Forces Proving Ground Command at Eglin Field, Fla., through the Forest Service, called the attention of the commission to further development of the jeep. Finally, in November 1945, the commission purchased one of the first civilian jeeps sold in Louisiana.

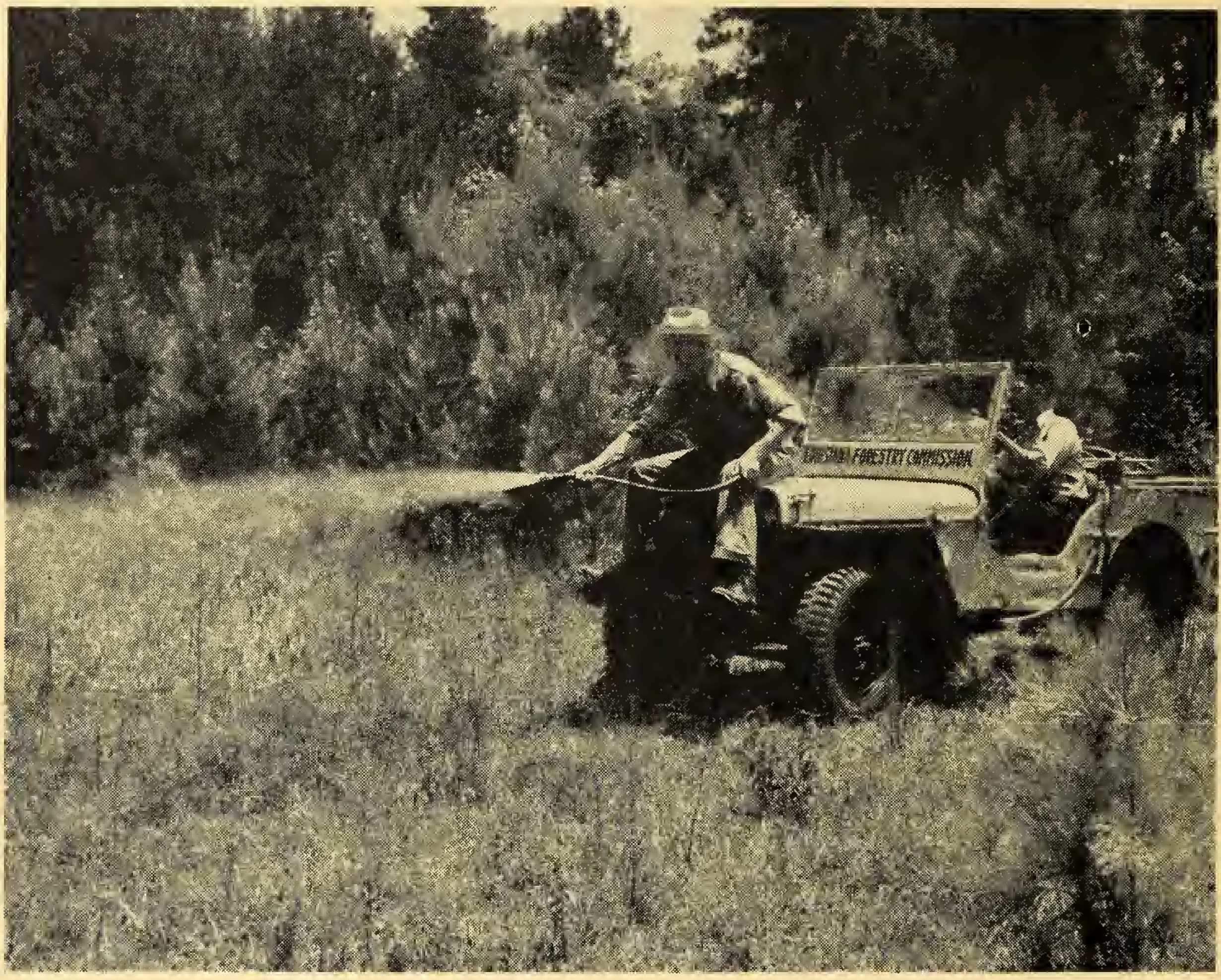
It was the idea of the commission to make a fire-fighting unit out of this jeep. Major Rowland's conclusions as to the combination of equipment were valuable, but the problem of the commission was

The four-wheel drive, low-range gears, snow- and mud-grip tires, and driver skill enable the jeep to climb steep slopes in the woods.

---

[1] See condensation of report in FIRE CONTROL NOTES, 7 (1) : 6. 1946.

the installation of a Panama pump on the truck. This was done successfully by the men at the central repair shop on the Alexander State Forest. The pump was mounted on a sturdy, hand-made bracket bolted to the head of the engine on the forward right side and driven by a belt from a double pulley mounted at the forward end of the crankshaft. A 70-gallon water tank was mounted in the rear compartment of the jeep. Thirty feet of "spray" hose and 20 feet of "filler" hose were provided. A second front seat was added. In January 1946, the jeep was assigned to a standard mobile crew area in southwest Louisiana, consisting of approximately 100,000 acres. Some 20,000 acres of this area are planted slash and loblolly pine. On the whole, the unit was more satisfactory than a standard pick-up truck similarly equipped. The one disadvantage was the size of the crew, which because of the higher-mounted water tank had to be limited to three men. Four men is the minimum crew usually employed by the commission.



The hose man varies his position with forest conditions. The stream here is from a forest fog nozzle, which operates at pressures of 80 to 120 pounds. Its spread is satisfactory, its pressure sufficient to give good penetration, and its use of water economical. Because the volume of the stream is small it isn't necessary to speed up the motor. The nozzle exhausts 6½ gallons per minute.

Four standard Army jeeps were bought by the commission in February 1946. A "perfect" factory installation of the Panama pump was made for the jeep by Mr. Speedy Freeman, of the Panama Pump Co., Hattiesburg, Miss. The basic change in the mounting of the pump was a relocation to the left side of the engine, with the sturdy mounting bolted to the inside of the fender and reinforced with a steel plate on the under side. The bypass was removed from the pump and placed on the water tank. The pump was still driven by belt from a double pulley on the front of the crankshaft, an arrangement which made more room under the hood. A tank was also installed on the jeep by the Panama Pump Co. It has a reduced capacity of 55 gallons, which gives a lower center of gravity and better riding space for extra crew members.

The first standard Army jeep was equipped and delivered for test in April 1946. Although the spring fire season was almost over, an immediate test period was set up to determine the use of this unit on special fires. It was used on control-burning projects and several large fires. As a fire unit, it has been highly satisfactory, though usage has been limited and no statistical data are available.

All of the units are to be equipped identically with the unit developed by the Panama Pump Co. Standard Army quarter-ton trailers have also been purchased. They will be equipped with water tanks having a capacity of from 150 to 200 gallons. They will be towed by the jeep to fires and dropped where travel is no longer practical. This extra, readily accessible water will supplement the small supply carried in the jeep-mounted 55-gallon tank.

At present the Louisiana Forestry Commission feels that the Louisiana Fire Jeep is the most valuable piece of fire-fighting equipment that can be used on small areas and to supplement the work of heavier types of equipment in larger areas. It will carry the two-way radio equipment at present being installed in the communication set-up. As equipped, the unit will be fast moving, highly mobile, and good for reconnaissance work. It can reach a fire in the early stage, scout the area, and attack the blaze. Where necessary, it will be reinforced with a second line of heavier equipment and more men.

The illustrations which accompany the article are of the standard Army jeep equipped by the Panama Pump Co.

Specifications for the Louisiana Fire Jeep

Type: Truck, ¼-ton, 4 x 4.

Cost:

	Civilian	*Army*
Truck	$1, 220. 11	$912. 20
Pump and tank	196. 20	191. 60
Top		52. 96
Paint		35. 00
	1, 416. 31	1, 191. 76

NOTE.—The four Army jeeps purchased did not have tops when delivered and it was necessary to paint them. Two were new and two were used, with 12,000 and 14,000 miles reading on the speedometers.

Measurements:	*Inches*
Length	122¾
Width	59
Height (windshield up)	67⅜
Height (windshield down)	52⅜
Ground clearance	8⅝
Tire tread	48¼
Wheelbase	80
Tire size	6.00 x 16

Weights:	*Pounds*
Shipping weight	2, 120
Curb weight	2, 220
With equipment, full water tank, 2 men at 150 pounds	3, 090

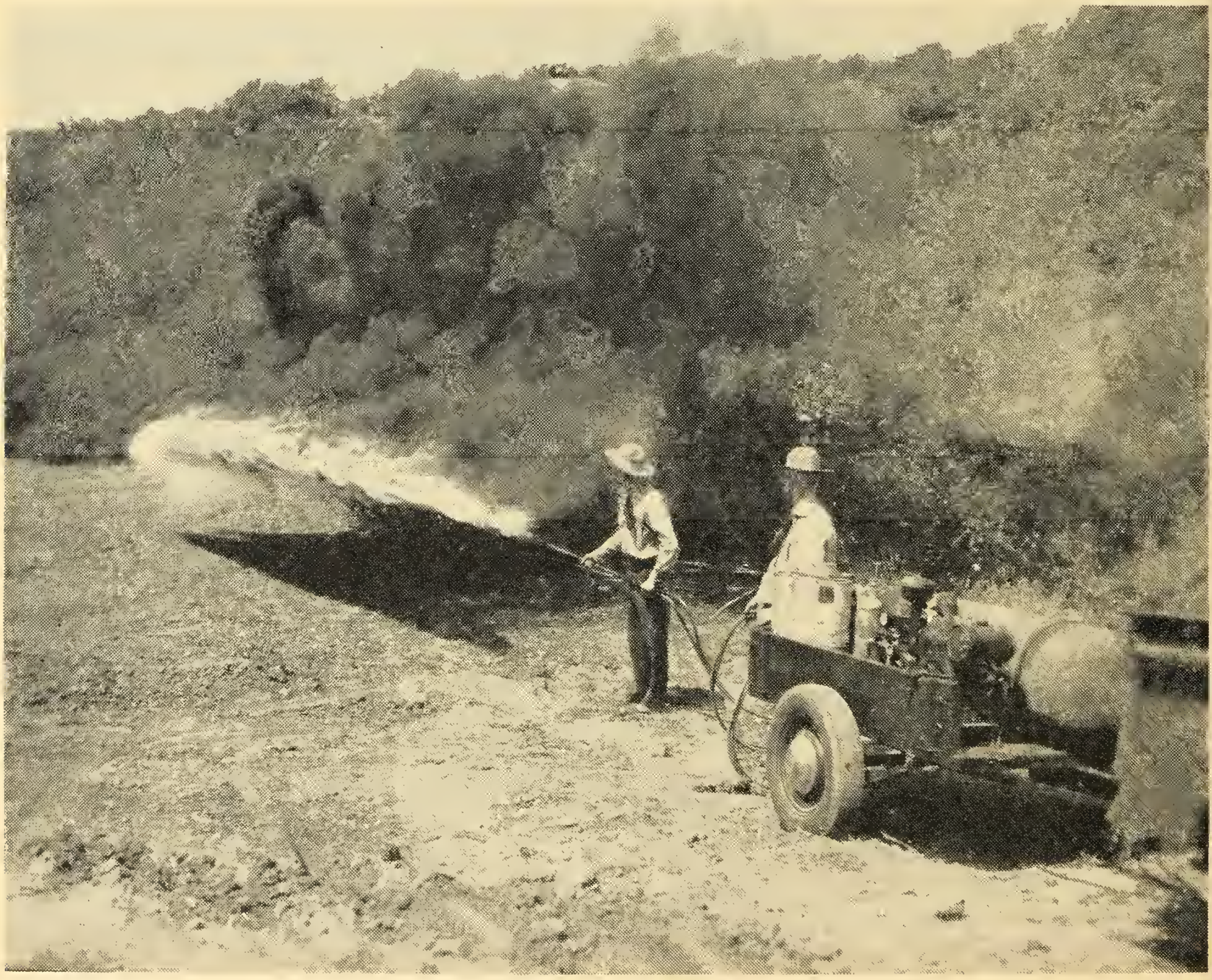
A NEW MOBILE FLAME THROWER

HENRY WERTZ, JR. *and* C. VERNON MAY

Los Angeles County Department of Forester and Fire Warden

Some time ago, Spence D. Turner, County Forester and Fire Warden, appointed a committee to study the problem of developing a better backfiring torch. With his encouragement, the writers worked out a combination butane-Diesel flame thrower which gives promise of being a valuable addition to fire control equipment. Several of the new units are now in use. It is hoped that they will be capable of backfiring cover more thoroughly on watersheds similar to those of Los Angeles County.

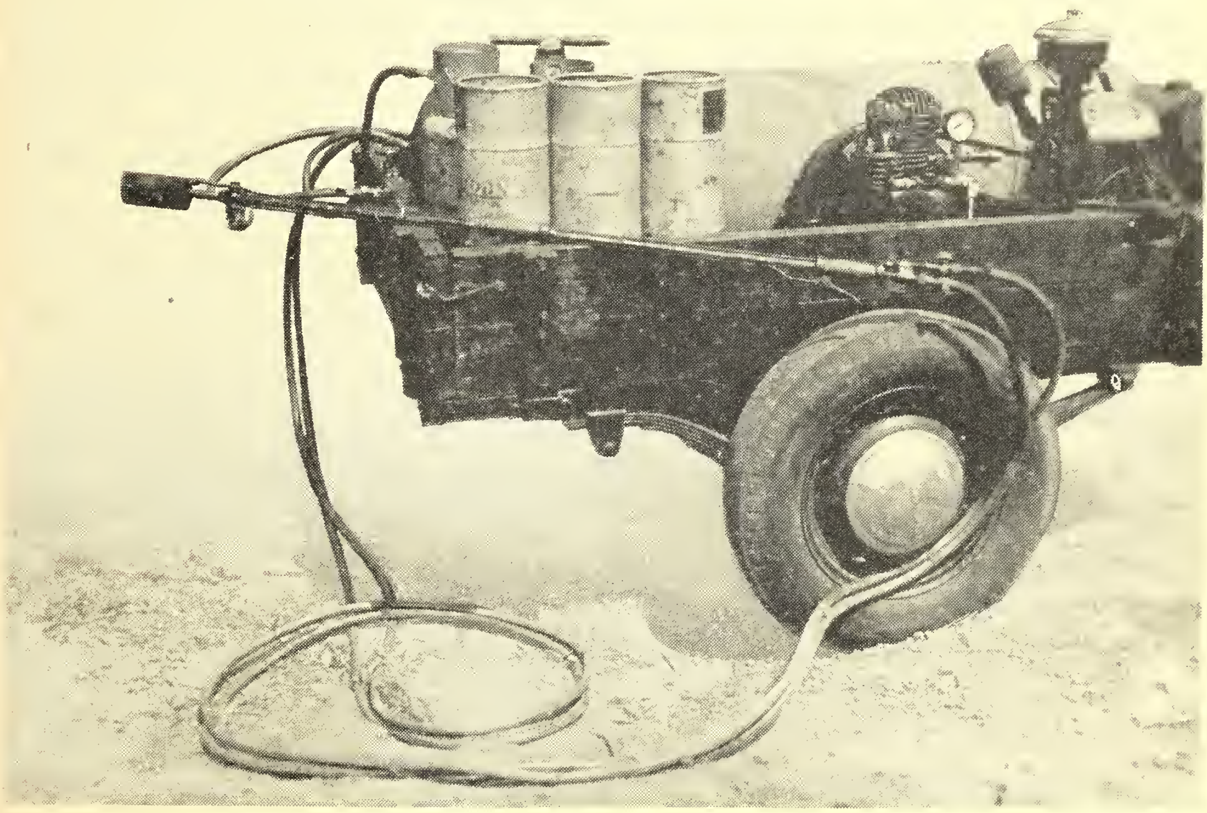
This unit, as shown in the illustration, consists of a gasoline-driven compressor and 70-gallon tank of Diesel oil, a battery of six 10-pound butane tanks connected to a manifold, 75 feet of ⅜-inch oil-resistant hose, and a specially built butane-Diesel flame-throwing gun. The gun is so constructed that the heat of the flame is far enough from the nozzle so no shield is required for the operator. Mounted on a



Fifty-foot flame thrown from portable flame thrower.

two-wheel trailer, it can be towed by truck over fire roads and then by tractor into strategic locations.

Of all volatile fuels with which experiments were made, a combination Diesel oil and butane gas gave the best results. These two fuels were already being used, the former in the tractors, the latter in portable fire-camp kitchens, etc. Jellied gasoline was tried, but it gummed up the pipes, caked the nozzle, and was consumed too rapidly. Liquid gasoline and kerosene tended to burn completely before reaching the maximum distance, leaving no burning substance on the brush or other cover. These three fuels were also unsuitable because their high volatility made them hazardous to personnel in backfiring.



Flame thrower equipment.

When backfiring in light cover such as grass, sage, and greasewood, the butane is used alone. It is capable of throwing a flame a maximum of 4 feet. In heavier materials such as trees and dense green cover, where there is very little dry undergrowth, the combination butane and Diesel oil is used. The operator can throw a mass of flaming fuel over a distance of 50 feet, leaving enough of the slower burning Diesel oil to insure thorough ignition. The heat generated by this torch is so intense that it burns the greenest vegetation cleanly, thus saving many man-hours of line-cutting with hand tools. In the heavier type of cover, more than 300 yards of fire line has been burned over in 19 minutes, using 20 gallons of Diesel fuel.

The mobile unit will be equipped with small portable units operating under the same principle. These will be useful in backfiring the more inaccessible areas.

The portable unit weighs 62 pounds. It has one 10-pound butane tank and a 3-gallon Diesel fuel tank with a hand-operated pump. Attached are 15 feet of oil-resistant hose and a lighter-weight gun than the one used on the mobile unit. It makes a compact unit 12 by 15 by 22 inches with retractable handles. This unit can throw flaming fuel for a maximum of 30 feet. The butane flame will last approximately 3 hours and has a maximum of 4 feet. The Diesel fuel, if used continuously, will last approximately only 3 minutes. However, with the usual intermittent bursts it will cover about 100 yards of fire line in average heavy growth. Back-pack boards are used to transport additional fuel supplies.

The larger mobile unit, operated by a three-man crew, has already been used successfully on several fires. It holds great promise for use when emergency methods are necessary to halt forest or brush fires.

FORESTERS ALOFT IN '46

P. A. Thompson, *Chief, Fire Control Division, U. S. Forest Service, and* D. M. Thompson, *Forest Ecologist, Southwestern Forest and Range Experiment Station, U. S. Forest Service*

The old timer shifted his heavy fire pack from one sweaty position on his aching back to another not quite so chafed and spat a stream of tobacco juice at a disinterested beetle. "Just look at that, would you! I *knew* that confounded smoke would be over on that slope! There she sits—4 hours down into that canyon and out onto that blasted ridge; and from here I can dang near spit on it! If I just had one of those flying machines. * * *" Nobody knows how many times such thoughts have been voiced since the first flight of the Wright brothers excited the imagination of men everywhere.

The history of aviation in the Forest Service has been a history of the struggle between an idea and its practical application. After the last war when men like H. H. Arnold, now General of the Army Air Forces (retired), flew fire patrol over the hills of California, it looked as though the airplane might become a regular piece of Forest Service equipment. However, inadequacy of communication between the ground and the air, plus the general lack of dependability of the airplanes of that day, prevented the development of "idea" into "application." Aerial reconnaissance has long been sporadically adopted as an emergency measure during periods of exceptional fire danger or poor visibility. It was not until the years just prior to World War II, however, that planes began to pay their way in saving of cost and time like any other piece of equipment. And it was not in the direction of detection that they first began to "pay off," but principally in the field of aerial delivery. During the late thirties, food, tools, beds, and supplies of all kinds were dropped on practically all the major blazes in the back country for the use of weary fire fighters thereby saving time, manpower, and pack mules.

The smoke-jumper program which was capturing the popular imagination before the recent war was a natural outgrowth of and a step beyond the cargo-dropping techniques. If supplies could be placed accurately at the site of a blaze, then why not men? Careful pioneering in the forest regions of the Northwest, from 1937 to 1940, had turned this idea into a functioning and highly valuable tool for use where "force enough, fast enough" could not be realized by ground travel.

Extraordinary impetus was given to airmindedness by the second World War. The Forest Service shared in this increasing interest. During the war the size of the smoke-jumper program was greatly expanded in order to conserve manpower. Results were encouraging. The practical use of airplanes in any situation where time, distance, or transport enter the equation is now being carefully studied.

Planned use of aircraft for the whole job of fire detection is being given a thorough try-out in several forest areas. The actual savings effected by the removal of fixed look-outs are applied against the costs of replacement service by planes. Trial runs indicate that in some places, particularly where lightning fires constitute the major risk, real savings are possible, both in money spent and in better protection of the forests.

Herbert K. Harris, office of Fire Control, Northern Forest Region, and William G. Morris, Pacific Northwest Forest Experiment Station, are developing planned programs for selected areas in Washington, Montana, and Idaho. They are studying carefully all phases of the problem, from degree of supplemental aircraft use to analysis of cost data. They are also testing the feasibility of new suggestions and ideas in the field of detection as they are advanced or evolved. They are pretty well satisfied, for example, that fast flying planes which will cover a given area more times in the same period than will slower planes now in use are going to prove more efficient in the long run. This is a somewhat startling new idea. It runs counter to the old theory that slow moving or hovering aircraft are more effective.

It has been proved that where detection coverage in excess of 40 to 50 percent is needed, it can frequently be provided more cheaply by air patrols. And what is more the whole system becomes flexible in its application. Increased flexibility usually means economy and greater efficiency. Where lightning causes nearly all the fires, areas need not be covered until the necessity arises. Ground coverage to be effective must be in place, each lookout manned and waiting before any real storms occur, an excessive use of effort. This is a common situation in the higher mountain ranges of the Northwest. Areas such as the Salmon Range in Idaho, the Bitterroot and Flathead in Montana, and the Chelan in Washington, may lend themselves well to total air-detection systems at the present time. Tests are now going forward as fast as practicable with the men and equipment available. Region 9 is using a float plane for detection over much of the Superior National Forest. One thing is certain—the trend is toward increased air coverage. Just where this will come into balance with fixed ground coverage is something for the future to decide.

Detection values have always been hard to catalogue and analyze. If "force enough, fast enough" is to be attained, detection must be prompt. In a sense then, detection is prevention—prevention of large and costly fires. Like fire insurance, it is hard to justify on a cost basis until there is a blaze. Suppression, on the other hand, is a natural field for wide use of planes. Suppression of going fires which are destroying public timber or forage values, and threatening watershed damage demand the use of any method which will put an immediate end to the danger. Public acceptance of the use of aircraft on going fires has always been prompt. In fact, the public occasionally has gone a step beyond the present capabilities of the aerial equipment in its demands for the use of spectacular methods.

The end of the war brought an increased interest in the aerial phases of forestry. Hundreds of applications have poured in from ex-paratroopers who want to re-experience the thrill of leaping into space high above the earth. Great numbers of school students want to sign up for this "front-line" duty. The smoke-jumper program, already proved successful, is then the first field for postwar expansion.

As originally conceived and worked out, the smoke-jumper squads were small units held in readiness to go into the remote areas of some of the West's most isolated forests. It might take a man on foot a day or more to reach such places. Fires in this type of country too often grew to sizable proportions before the firemen on the ground could reach them. Whole crews of men with pack animals were needed to bring in the tools and supplies. Sometimes it took weeks to put out the last spark, and large areas of timber were scorched and burned.

During the war, when manpower was scarce, smoke-jumper crews were grouped by necessity in larger units for use on big fires. The success of this wider use led the Regional Foresters to set aside several million acres of remote and isolated country. These are now being protected entirely from the air—from the detection of lightning strikes to the suppression of sizable going fires. To date, the smoke jumpers have justified the additional trust.

The speed with which smoke jumpers can be put on a fire holds out hope for solution of the vexing "flash fuels" problem. In relatively accessible areas where large bodies of flash fuels exist, the lag between detection of the smoke and arrival of the first men on the fire has always been discouraging. Blazes on such fuel types can in 30 minutes or less reach a size too large for 1 or 2 men to handle. A fast-acting squad of smoke-jumpers, say 10 to 25 men, can get to fires starting in the grass-brush fringes of the timber bodies and stop them before they reach threatening proportions. If that "first-run" that fire fighters dread can be stopped by fast aerial delivery of sufficient force, then protection in such areas takes a long step forward! There are millions of acres of this type, particularly in Idaho, where the inflammable fringes of the Boise, Salmon, and Payette Forests have been recognized for years as a potential threat to adjacent valuable timberlands.

Taking thought a step further, what has been the experience on large fires in the past? Many fire chiefs have watched helplessly from a ridge top while a sector of their line "blew-up" to start a run into a new drainage. In order to reach this new front, men have had to detour into almost impassable canyons and up steep slopes. They have hiked for hours to reach the point of spread and then arrived too exhausted to be effective! In one such situation last summer, smoke jumpers from an air base more than 50 miles away were used successfully. They arrived at the breakover more quickly than men from the main suppression crew could possibly have done.

The use to which air aids can be put on big fires is easy to visualize. Scouting on any large fire is a vital factor in expedient and adequate use of manpower. New development in air-to-ground communication, using ultra-high frequencies is opening up new possibilities. The fire chief must have accurate information delivered without delay. Photographs taken from the air and developed in a matter of minutes in the plane, can be dropped to the "command post" of the fire boss. This is unquestionably a most effective scouting service. If photographs of the area made prior to the fire are always at hand, showing bodies of fuels and details of terrain not gained from ordinary maps, the overhead on any large fire can direct prompt and accurate action.

It may not be too fantastic to visualize a future fire chief on a project fire, maintaining his daytime control from a plane. Aloft, he may assign ground forces to their sectors, as factors of slope, fuel type, and wind, change the picture; and dispatch smoke-jumper units to "spot fires" out ahead of the main fire or to sectors of critical need as they develop.

Air freighting into the back country or cargo dropping may be more prosaic, but it is just as essential a part of the whole aerial picture. As previously brought out, it was in this phase that the airplane first began to pay dividends in savings to the public treasury. In 1945, three-quarters of a million pounds of tools, equipment, and supplies were dropped to camps by parachutes or put on back-country landing strips by air delivery. Crews going in to fires have been able to "travel light" and find food and tools on the spot. This lessens the fatigue factor and is a vital addition to the straight saving in delivery time and cost. Firemen can be "serviced" cheaply by light airplanes where the pilot doubles as dropper. Tossing out a 35- to 50-pound pack to a one- or two-man crew at the scene of action can effect great savings in the use of highly trained personnel.

The use of expendable equipment on fires is increasing. Delivery of hot food to crews is an accomplished feat, and the use of paper food containers obviates the necessity of packing out anything but beds and tools. Experiments with the use of paper beds indicate that before long beds too may be expendable. Crews who come off a fire with nothing in their hands but the tools with which they work will obviously be ready to go on more quickly to another blaze.

Extensive freighting into the back country calls for landing fields. These fields fall into two major classifications; class A for use by larger cargo-type planes, and class B for smaller light planes. Where heavy freight or crews of men are to be delivered, class A fields with level runways and clear approaches are necessary. Quick pick-up or delivery of one or two men and light equipment can be made on class B fields, which may be small cleared strips with one-way landing and take-off chances and sloping or undulating runways. Forest Service pilots must be good! In Oregon and Washington, tentative planning calls for class A fields at 12- to 20-mile intervals and class B strips as close as 6 to 10 miles. In most areas, however, rough topography will prevent attainment of this spacing. Where it is possible, it will bring men and supplies to within an hour's hike of practically any portion of most forests. Airfield development of this spacing would make it unnecessary to construct a large part of the planned road and trail systems on many national forests. Therefore, use of aircraft immediately becomes of interest to transportation planners.

Bringing back highly trained personnel, such as smoke jumpers, becomes a factor of increasing importance as their use expands. Quick return to base by air can double the effectiveness of a given squad during periods of high fire occurrence such as follow a series of lightning storms. Furthermore, in case of injury or sickness, it is difficult to measure the value of air transportation in saving lives and suffering.

Straight transportation of skilled personnel over long distances on the Western forests steps up the efficiency of overhead during the summer. In 1945 more than 1,000 trained fire-overhead were moved by airplanes to fire jobs. In one instance the Army Air Force moved 200 fire fighters 300 miles in a few hours.

In many places throughout the mountainous West, much valuable time may be lost in travel. On the Wallowa National Forest in Oregon, for instance, overhead and men leaving the Snake River Canyon must travel down the river to Lewiston, Idaho, and thence around to Enterprise, Oregon, by car to get back to headquarters—a distance of over 200 miles requiring almost 2 days' travel. This same trip can be made by air in less than an hour! Light planes with 2- or 3-passenger capacity are being used in many places like this in the Western regions for several months during the field seasons.

Four new, bright-red, four-place Stinson airplanes were purchased by the Forest Service for fire control use on the Western forests. They have been kept busy. When not in use by Fire Control, they have been in demand by the other divisions which pay a flat-rate charge for the service. The savings in cost to the renting parties have been amazing at times!

A new program is under way in Region 3, Arizona and New Mexico. When disastrous fires occurred on the Gila Wilderness Area during the early spring fire season, observers thought that smoke jumpers might have prevented considerable loss. Great altitude and the strong winds prevailing over the upland mesas have in the past discouraged smoke-jumper tests. Now, however, trials are proposed by a squad of jumpers and cargo droppers from one of the Northwest Regions. It is thought that new methods will be evolved or existing practices altered to fit the situation in the Southwest. Dovetailing the April to July fire season of the Southwest into that of the Northwest Regions may provide a longer period of training and usefulness for the present smoke-jumper program.

Helicopters for use by the Forest Service are still in the offing, but testing is going ahead as rapidly as possible. Present limits on useful load capacity, altitude range, and functional dependability, are being extended slowly by Army search and rescue units working out of March Field, Calif., in cooperation with the Forest Service. The R–5 model of the Sikorsky helicopter is the only one that has been tested, since the Army had the machines and the pilots to operate them. Other manufacturers are, however, entering the "direct lift" field, and it may not be too long before competition and increased demand for their specialized service will bring an "egg-beater" on the market which will fit Forest Service needs.

Bombing fires from the air has always kindled interested speculation by the general public. It has enthusiastic backers in the Army and the Forest Service. Army search and rescue units have a moderately successful record in the flat pine belt of Florida where water and chemical bombs were effective in slowing the progress of fires. Trials are to be continued during the summer of 1946 on an area in the high, rugged mountain country of the Lolo National Forest, in Montana. B–17 bombers, based at Great Falls, will drop special 165- and 300-gallon tanks on actual and test fires.

At this stage of program development, expert assistance is needed, Standards of practice and method must be established on a national basis if "foresters aloft" are to be efficient and effective. Fire Control has been fortunate in obtaining the part-time services of Don Hamilton, head of the Equipment Section of Engineering, who will act as aviation consultant for the Washington office and all Forest Service Regions. Mr. Hamilton, formerly a colonel in the Army Air Forces, has had wide experience in operating and maintaining aircraft of all types. During this summer he is traveling throughout the Western regions studying Forest Service aviation equipment and aerial operations.

The authors are well aware that the Federal Forest Service has not had a monopoly on the use of aircraft for forestry and fire fighting. Many State organizations and other Federal agencies have made wide use of planes for years. However, there has not been time to contact these organizations and gather information relative to their current programs. We have, therefore, confined our discussion to aviation as it concerned the Forest Service. Greater scope and range of protection afforded by a well-organized aerial service may lead eventually to a cooperative effort on the part of the various States and Federal agencies. It is expected that effective teamwork will result here as it has where activities have overlapped in the past.

The successful steps already taken in the use of aircraft in forest fire control work send thoughts flying ahead to search out other and practicable steps which undoubtedly lie in the future. Success in speeding men and supplies to fires opens new and exciting avenues of conjecture to the men who must plan for transportation and for recreational use of our forests. But for fire control planners it has passed the point of conjecture. Use of aircraft is an integral part of our job. "Force enough, fast enough" is now on the visible horizon.

○

Volume 8 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1946

Contents

Page
Results from mechanical fire line construction 1
A. W. Hartman
High lights from results of helicopter tests 10
Ira C. Funk and Carl S. Knudsen
Novel method of fire area measurement 16
Prescribed burning in the Florida flatwoods 17
C. A. Bickford and L. S. Newcomb
Outline for analysis of fire prevention action as applied to a particular fire 24
Hose storage rack 25
L. A. Horton
Jeep tanker 26
H. M. White
Preventing gumming of back-pack pumps 27
Region 5
Preliminary report on aerial detection study 28
R. L. Hand and H. K. Harris
Instruction for preservation of fire equipment by Army methods 33
Nels H. Orne
Army range finder impractical for fire detection 36
W. Ellis Wiltbank
We produce fire training films 37
J. Whitney Floyd
The new ration E 39
John B. Holden
Brush hook rack 40
L. A. Horton
Tractor transportation on fires 40
A. B. Everts
Few forest fires in Germany 41
Edward Ritter
Army explosives for hazard reduction 42
G. B. Johnson
Paradoctor appointed in Region 1 44

RESULTS FROM MECHANICAL FIRE LINE CONSTRUCTION

A. W. Hartman
Assistant Regional Forester, Region 8, U. S. Forest Service

Paralleling the coast from North Carolina to Texas is an area of approximately 250,000 square miles, or 160,000,000 acres, grading from flat coastal plain to rolling uplands. The greater part of this area is forest land, about 62,000,000 acres in the longleaf-slash pine type, and most of the remainder a mixture of shortleaf-loblolly pine and hardwoods.

Following the cutting of the heavy original timber stands, the shortleaf, loblolly, and slash pines tended to prolific reproduction, limited by the frequency of wild fires. The longleaf pine, which has infrequent seed years, came back in fair but understocked stands where team logging left small or defective but seed producing trees. Where clear-cutting and railroad skidders, tearing down all but an occasional sapling, were used and followed by intense logging debris fires, there are today large areas with only scattered clumps of reproduction.

With fire protection, the potential timber capacity of this entire forest region is tremendous. Because of the long growing season, favorable climate and soils, both pines and hardwoods will grow with almost unbelievable rapidity. On large blocks of the better sites protected from fire annual growths of 400 to 600 board feet per acre per year are common; 150 to 200 board feet per acre is common to the poorer sites. Stands of 20,000 board feet per acre are frequent on land that someone tried to farm 40 years ago.

Also, accessibility and unsurpassed market conditions combine to create a forester's dream. Heavy demands for fence posts, pulpwood, poles, piling, and sawlogs give opportunity to practice a succession of good silvicultural thinnings and cuttings, each at a profit. All products enjoy exceptionally high stumpage values.

The Fire Problem in the Southeast

The one thing standing in the way is uncontrolled fire.

From the days of the earliest settlers, light burning, annual or biannual, has developed into accepted custom and tradition; in some sections it reached the dignity of a civic duty. In the longleaf areas the wire, sedge, and other grasses with their high, luxuriant growth generate a real conflict between the stockman and the tree man. Large numbers of cattle and sheep graze the piney woods. By tradition, unfenced lands are "open range" for any stock owner. A person can easily make a fair living by running a herd without cost on the other fellow's land. The grasses make pretty fair forage in the summer and cure after frost into a dense mat of natural hay on which the stock winters. The conflict comes in the early spring when stock needs fresh grass. The new sprouts are buried under the dead growth which will accumulate from year to year. If a fire removes this cover, a luxuriant new growth of grasses is available for grazing in a matter of days.

Years of steady work by many agencies toward overcoming this hereditary practice of burning has won the majority to the side of protection, but there remains among the rural residents a large aggregate of citizens who still feel the urge to draw their matches at the drop of a leaf. The problem of the land managers and fire control agencies is to squeeze the area that can be burned by these often well-meaning fire setters.

The deep mat of dead grass, augmented by needles, leaves, and shrubs, continuous over great stretches of woods, sets up a high fire potential. Such fuel is flash, burns explosively, and produces hot, high flames that often go into the crowns of the trees. The fires spread with extreme rapidity. Before the high gusty winds, common to the region in early spring, heads of fires frequently run in the speed range of 2 to 3 miles per hour.

State foresters and individual owners tried to interfere with the spread of these fires, but their meager forces with hand tools often could do little more than keep them from crossing roads, streams, or like barriers. Various fire-control men reached the conclusion that a reasonably good job of suppression in the flatwoods could not be done by hand. They were handicapped by both lack of funds and lack of equipment, but they did develop tankers and made a start on heavy plows.

CCC Hand Control

The picture changed with the advent of the CCC program in which this section enjoyed a large share. Camps on State, private, and national forest lands placed around 75,000 young men in these woods. They were organized in crews with their foremen, supplied with transportation and plenty of hand tools, were well trained, and always available in numbers for a quick getaway to a fire. At the height of CCC the South was in a favorable position to control fires efficiently with manpower, if men and hand tools could do the job.

The CCC boys did a man's job, but it became more and more evident that their efforts were out of proportion to the results. In the easier fire weather they did pretty well. During bad fire weather, with rakes, flaps, and back-pumps, they fought valiantly, frequently to exhaustion, only to have fires get away from them. There were such instances as a fire being attacked when small, receiving a plentiful concentration of fresh crews, but still, a few hours later, reaching 10,000 acres.

Foremen shook their heads over the brutal work they were requiring of their men. State foresters, rangers, and supervisors who were observant became convinced that this was the wrong answer. The man with the match was still master of the suppression forces.

Building of Mechanical Units

As time went on the future prospects of hand-tool suppression looked even darker. Despite the handicaps and limitations, the aggregate of control efforts had resulted in a marked reduction in the frequency with which many areas were burned—large areas were protected with but small percentages of burned acreage over a number of years. With this protection, suppression became more difficult year by year as the amount of fuel on the ground increased. Seedlings lived and grew into dense stands of advanced reproduction, but thickets of bushes and brushy growth also thrived. On the better growing sites, unburned for 10 or 12 years, the fuel and brush accumulations became so heavy as to make hand tools entirely too slow and ineffective. Field men also realized that CCC must sooner or later end and fire crews would have to come from slowly gathered farmers, loggers, or distant town labor.

In those days they began moving toward mechanical fire-line building. The only fire plows in sight were a pusher type developed by the Arkansas State Forester and those being built by Mathis and Rome. Powered by 35- and 50-horsepower crawler-type tractors, they built a good line about 5 feet wide through the heavy palmetto-gallberry sod cover. As more and more of these units were placed in operation, their value was quickly established. When they could be gotten to a fire, they built a line at a rate of about 1 mile per hour, a line which would hold on the flanks and which could be backfired to stop a head fire. They made suppression surer and faster.

The weakness of these heavy units was the difficulty and long elapsed time required to get them to a fire. The four-disc-type plow weighed 3,600 pounds; the two-disc type about 2,400 pounds. The smallest tractor that could successfully pull the two-disc plow weighed 12,000 pounds. Transporting these units to a fire required a heavy truck-trailer which carried the tractor and towed the plow. On ordinary roads the loaded outfit traveled 10 to 12 miles per hour, with travel rate becoming slower after turning into back-country or woods roads. The point beyond which the heavy truck could not travel was often reached while still far from the fire, necessitating "walking in" the tractor for two or more miles. These units were quite helpful, but the limitation of slow, ponderous travel made their time of arrival disappointingly late. In the fast-burning fuel types, fires often reached class D size before a plow could be put to work. The plows stopped some fires at a reasonable size, but in the main their role was to help keep already large fires from getting much larger.

Brief study of the situation pointed out the necessity for a line-building unit that could be delivered on the fire at a speed which would appreciably reduce the critical and all-controlling elapsed time between start of fire and effective attack. We knew speed of travel would have to be bought through the sacrifice of some of the valuable characteristics of the heavy units. The hope was that a unit could be developed which would build the least line one could get by on, translating the weight saving into travel speed—a unit that could control a fire in medium fire weather, and in bad fire weather could get on a fire while it was still small and hold it until a heavy plow could get there.

The controlling specification was a tractor-plow unit that could be transported on a 1½-ton stake body truck. In the spring of 1944, a Clarkair tractor weighing 3,175 pounds was obtained for experimental purposes. The engineers and mechanics went to work and created a light plow. A series of field trials and alterations resulted in the plow known as the Rangers Pal, weighing 465 pounds. The total 3,600-pound unit would not seriously overload a 1½-ton truck and could travel at 50 miles per hour on good roads.

The small Pal plow, used where there are no stones, is 7 feet long and 28 inches wide. Mounted on a central beam front to rear are: A three-height tractor hitch; an 18-inch rolling coulter; a middle buster plow point; two 20-inch discs; a worm gear depth adjusting device; two short wings to roll back the overcast; and two wheels with 4.00 x 8 tires which ride within the plowed furrow. This plow builds a furrow 28 inches wide at the bottom. With side slopes and overcast of dirt, the total width of mineral soil line is 48 to 54 inches, depending upon the nature of the soil and the depth to which the plow is set to cut. In fire line plowing it works best at a speed of 1½ to 2 miles an hour on level ground, but will plow up to 3 miles per hour.

In the summer of 1944 the HG Cletrac became available. Its wider tread, greater clearance, and less weight (3,000 pounds) made it more desirable for plow use than the Clarkair. Seventeen of these HG tractors were purchased; our equipment shops built 15 Pal plows and 2 middle buster plows. These last were for use on stony ground found in the Talladega Mountains in Alabama. Stake trucks were rigged for fast loading and unloading. These units were distributed to our most critical fire districts and used on the season's fires. To the extent that sets were available, these units were equipped with radio. The suppression results from these plows far surpassed our expectations. They hit fires very quickly and built line with a speed that prevented build-up and demonstrated that they could handle a fire on a class 5 day.

In 1945, 12 more of these units were constructed and radios installed on all but a few of them. Radio is vital toward getting the most out of a unit. It enables the ranger during bad fire weather to distribute his plows at strategic locations, start them off immediately upon discovery of a smoke, and give the crews directions while traveling. When the units are finished with one fire, they are dispatched to another without loss of time.

With the great variations of soil and ground cover there can, of course, be no one all-purpose weapon. It is presently estimated that our conditions call for three distinct sizes of units: The light Pal plow for use in the grassy, more open longleaf type; an equal weight unit with a middle buster type plow for the hill country up to 30 percent slope; and the heavy two-disc Mathis type plow in the luxuriant and dense cover found in Florida and the Carolina coastal areas. Middle weight plow units have been built for use in the heavy but less dense cover found in the inland loblolly type. These middle weight plows follow the same general design as the Pal plow but weigh around 900 pounds, are raised and lowered by a hydraulic jack, and are pulled by a T–6 tractor weighing 6,750 pounds. For these, special carriers were designed, consisting of a Hi-Low semitrailer with a 1½-ton truck for a prime mover. These carriers will make 40 miles per hour on good roads. To speed up travel and increase their range, Hi-Low semitrailers have been built to carry both the heavy Mathis plow and its tractor. The prime movers are 2½-ton 6×6 (Army type) trucks for the heavy going, and 2-ton 4×4 (Army type) trucks elsewhere.

Method of Use of Mechanical Units

The size of the crew with each plow unit is varied with type of country and existing class of fire weather. A typical crew is composed of a lead man, tractor driver, backfiring torchman, and follow-up man with back-pack pump and flap. Such a crew has successfully suppressed 6 successive fires in one class 5 day. One famed crew on a Mississippi district handled 72 fires last spring by themselves. If it appears that there will be much of a mop-up job, a hand-tool crew is dispatched to take over that part of the work and release the plow crew for another fire.

Attack by a single plow unit is an undesirable tactic. Because there were not enough units available for the job at hand it was necessary on all but a few of the fires studied. (Seven more Pal units are under construction and some doubling up can be practiced next spring.) On a number of occasions ranger districts had more going fires than plows. Attack was delayed on too many fires. They got pretty big before plows could be disengaged from other fires. On days of lower fire occurrence, two plows attacked some fires and there were a few opportunities to use three. The rapidity of suppression under such attacks was so striking as to indicate that the desirable action and the key to obtaining a reasonably small percent of burned acreage is to dispatch two plows to many of the class 3 day and to all class 4 day fires; three plows on all class 5 days or to any incendiary fire with numerous sets on any class fire day. The secret of success is the elimination of each fire in the shortest possible time. Then, all units are available for assignment to other fires. Another factor makes time important. On bad windy days heads run rapidly and produce a long cigar-shaped burn. Winds frequently make a 90° shift. The longer the time before both sides are controlled, the greater the risk that wind shift will turn one or the other flank into a broad front head fire.

A plow unit requires an appreciable investment of funds. The national forests in Region 8 have within their protection boundaries approximately 10,000,000 acres where tractor plows will work to advantage. State foresters and large lumber and pulp companies have as their long-time objective, as funds and facilities become available, adequate protection of an estimated 100,000,000 acres of potential "plow country." The State organizations have been adding tractor plows to their forces as their funds will permit and some units have been acquired by industrial landowners. Two fundamental protection questions to be resolved are: "What method of fire line building gives the best combination of effectiveness and economy?" and, if the advantage is with the plows, "To what extent will investments in mechanized units pay off?"

Comparison of Results

A preliminary study was made this summer to assess and compare the results so far obtained. We wanted to know whether our present investment in plow units had been good business and, if so, to obtain indications as to the extent we are justified in making further investments and to give guidance to other fire protection agencies who are considering trying or expanding mechanical fire line building.

An analysis was made of 315 fire reports for the calendar year 1940 from the Catahoula, Evangeline, Kisatchie, and Vernon units in Louisiana, and for the year 1941 from the Leaf River, Chickasawhay, and Biloxi Ranger Districts in Mississippi.

The area protected within these particular ranger districts is 1,132,926 acres. On and around them is found the highest concentration of man-caused fires in the United States. This group of ranger districts enjoys the dubious honor of a 5-year average of 752 man-caused fires per year. Besides the bare figures of high occurrence, other factors contributed to the severity under which the plow units were tested. Most of the fires are incendiary, planned by men who know the areas intimately, choose the time of day, weather, and burning conditions, and place numbers of sets, all calculated to give fire every possible advantage. The fire setters make it a little rougher by crowding large numbers of fires into particular days. There were 2 separate days last spring when the Chickasawhay District had 26 fires, and 4 days with concentrations of 15 to 20 fires.

In the years 1940 and 1941 the 7 districts had no fire plows but conditions were about as advantageous as could be for good hand-tool results. The areas studied then had 8 CCC camps, or about 1,200 active young men organized in crews with their foremen, transportation, and some light tankers. The boys were well trained, crews could be gotten together and started quickly, and on bad fire days were often placed out on standby. Fires were usually attacked with a truck load or more of men with followup available. The results obtained by these CCC crews must be considered as quite good for hand-tool suppression, and far superior to what could be expected from equal sized crews gathered from farms, sawmills, or towns.

For comparison, the actions on 526 plow-fought fires on these same districts in the spring season of 1946 were analyzed. There were 6 heavy Mathis type plows and 11 Ranger Pal plows on these districts during the early part of the fire season, and 6 more Pal units were added during the course of the fire season.

To prevent distortion, we threw out of the study those outside fires which were simply cut off near the boundary, class 2 day fires because they were so inoffensive as to give no test to suppression methods, and fires under 5 acres in final size. A fire in the flatwoods during strong burning weather that is suppressed with hand tools at less than 5 acres usually represents special circumstances, such as being held by roads, streams, or fields.

Table 1 shows the comparative results from hand-tool crews and tractor-plow crews under like burning conditions.

Table 2 gives the percent of fires which became class D size (100 to 300 acres) and class E size (over 300 acres) under each method of suppression. The test of a method is rather well measured by its results under bad conditions. Historically, this region has lost the big part of its burned acreage from those few fires that were not well held; fires that on severe fire days were too much for the available manpower.

Table 3 shows the complete cost of each of the three sizes of plow units. Because much of our equipment was Army surplus and some old CCC surplus, these costs are considerably below the expenditure probably required to obtain similar items under present market conditions.

TABLE 1.—*Size of fires, and work required to control them by hand tools and by plows*

Class fire day	Average size of fires						Average time on line building		Average maximum men per fire (includes mop-up)		Average length of held line	
	Hand-tool control			Plow control								
	Beginning of attack	Final	Increase	Beginning of attack	Final	Increase	Hand tools	Plows	Hand tools	Plows	Hand tools	Plows
	Acres	*Acres*	*Percent*	*Acres*	*Acres*	*Percent*	*Man-hrs.*	*Man-hrs.*	*Number*	*Number*	*Chains*	*Chains*
3	23. 0	57. 2	149	14. 4	28. 7	101	20. 15	5. 37	18. 0	5. 6	75. 2	57. 1
4	45. 6	93. 7	105	17. 7	36. 5	112	24. 99	5. 86	22. 6	6. 4	83. 2	67. 7
5	49. 8	422. 2	748	22. 1	67. 9	207	52. 51	10. 40	30. 3	8. 2	160. 3	83. 0

TABLE 2.—*Percent of total fires reaching class D and class E size, by hand-tool and plow suppression*

Class fire day	Class D size (100 to 300 acres)		Class E size (over 300 acres)		Total over 100 acres	
	Hand tools	Plows	Hand tools	Plows	Hand tools	Plows
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
3	18. 6	2. 6	2. 0	0. 0	20. 6	2. 6
4	11. 2	5. 1	4. 0	0. 4	15. 2	5. 5
5	22. 5	11. 2	16. 9	2. 8	39. 4	14. 0

TABLE 3.—*Cost of plow units*

Part	Heavy plow unit		Medium weight unit		Light plow unit	
Truck	(2½-ton, 6 x 6)	$2,000	(2-ton, 4 x 4)	$1, 800	(1½-ton)	$800
Hi-Low trailer		800		800		
Tractor	(D–4)	4, 000	(T–6)	2, 400	(HG Cletrac)	1, 400
Plow		750		700		275
Radio		450		450		450
Total		8, 000		6, 150		2, 925

The 526 (analyzed) plow-fought fires, if suppressed by hand, (figuring costs upon the manpower required to suppress with hand tools the 1940 and 1941 fires and the wage rates prevailing here last spring) would have cost an average of about $57 each for suppression labor and crew bosses, or around $30,000. Although our cost accounting system does not provide for exact identification of costs by individual fires, by totaling the manpower and equipment time from the fire reports and applying current wage rates and our standard costs of equipment, operation, and depreciation, it was found that the cost of suppressing these 526 fires was approximately $6,800, an average of about $13 per fire. Thus, there is an indicated saving of $23,200 or $44 per fire in suppression costs.

Table 1 demonstrates the reduction in acres burned per fire, under the different fire weather conditions, when fought by tractor plows instead of hand tools. The most significant figure is the reduction in the size of area burned under plow control on the worst fire days. What the losses from fire damage to reproduction and timber would have been on the acres which probably would have burned except for the plows is too speculative to reduce to reliable figures. The study did tell us the 315 hand-tool suppressed fires burned 47,523 acres, whereas 526 plow-fought fires burned 18,015 acres. Hand-tool controlled fires averaged 150.8 acres per fire as compared with 34.2 acres per plowed fire. Further studies may show that these averages will vary both ways from year to year or according to the types of country, but the spread is so significant as to assume the position of major importance.

Conclusions

Reduction in the amount of damage from fire is the primary objective of a fire control organization. Whatever the average damage per acre resulting from wildfire in any given stand, it seems axiomatic that a mechanical method of suppression which gives promise of saving well over two-thirds of the former losses, besides the reduced cost of operation, will have paid its way after a very few fires.

It is also our judgment that mechanical suppression will prove to be a firm base for far better fire prevention. In a section of the country where so many people lean toward promiscuous burning, they will give really serious consideration to the teachings of foresters only after it is well demonstrated to them by stopping fires with dispatch that the foresters mean business. When they see us, the preachers of fire prevention, fighting fire ineptly, permitting what they judge to be unnecessarily large burns, they question the real sincerity of our talk. Where suppression action has not been too good, we even encounter the idea among the residents that under all the talk, the fire organizations really want quite a bit of fire in order to keep their jobs alive.

From the true incendiary, the fellow who sets out to burn a large piece of the other man's lands to save himself from buying spring feed for his stock, we expect a considerable increase, for a while, in the number of fires. The stockman usually has in his mind some certain size burn as an objective. He can often get such a burn from one fire fought by hand tools. If a tractor plow suppresses his fire at small size, he will repeat his fire settings again and again on other days, trying to get the size burn he originally wanted. This will be annoying at the time, but those actions tend to segregate and identify these burners. They follow predictable patterns of action until it becomes more and more probable that properly placed guards will be able to apprehend them in the act. With some court convictions and the increased risk of being caught, we believe that fast suppression will gradually discourage this worst source of fires.

Another major source of fires on the national forests of this Region has been the "job fire." When money was short, it was very common to have a scattering of fires set so the boys in a community could get some work putting them out. In ground cover where large crews are required to keep fires from reaching critical size, these "gravy train" set-ups have the ranger in a bad defensive position. With fast mechanical units employing only a few reliable men, each unit easily more effective than 25 good men, the "job fire" people find that they have lost their power, the ranger is independent of them, and they are not hired. They soon discover that the cause of their temptation is gone.

Another important gain from mechanical suppression not brought out by statistics is the reduction of the "fatigue factor." The physical demands placed on hand crews by fast-spreading hot fires can be so great that men frequently play out before completing suppression of one fire, and they are seldom in condition to be assigned to a new fire without a long rest. Plow suppression does not overfatigue the crew, and the men are able to act energetically on successive fires all day long if needed.

The big question is, Does mechanical fire line construction pay? We conclude from the data at hand that an organization with any appreciable area of "plow country" to protect cannot justify the large suppression bills and heavier damage losses that occur without such equipment.

How far can one go in investing in equipment? In the first place, it has required the current condition of the lumber market and the price lists to bring home not only to the general public but to a lot of people in the business that we have become a chronic "have not enough" lumber nation. Our timber stands and vulnerable reproduction have attained a monetary value and a place of economic importance that jolts us all. Fire damage from now on will have to be calculated a lot higher than when it was thought "there is plenty more."

There can be no simple formula applicable to different areas. There are some good guides.

Depending upon the local rate of fire spread, there needs to be an outfit within a travel time permitting attack before the fire gets to critical size. Critical size would be governed by the values at stake where the fire is burning and the threatened values where the fire is heading.

The frequency of fires, the number that will have to be fought per year in a given area, is a part of the equation.

In the area studied, with one fire per year for each 1,500 acres, our speculative calculations indicate that we can afford a small unit for each 30,000 acres of our reasonably well stocked stands. That would mean an initial investment of about $0.10 per acre. It costs around $12 per acre to plant trees on denuded land. Our pine stands have an annual growth value of $1.50 to $5 per acre with growing stock on the ground which will bring from $20 to $75 per acre in the lumber market. The investment in mechanical equipment for fire line construction looks like pretty cheap fire insurance.

HIGH LIGHTS FROM RESULTS OF HELICOPTER TESTS

IRA C. FUNK and CARL S. KNUDSEN

Mechanical Engineers, Arcadia Fire Control Equipment Development Center, Region 5, U. S. Forest Service

Operation

Since October 1945, the testing of performance of Army Air Force helicopters in mountainous areas has been conducted on the Angeles and San Bernardino National Forests, Region 5, in cooperation with the 62d AAF Base Unit (Air Rescue Service), March Field, Calif. The first ships furnished the test project were the Sikorsky R-6 model.

Helicopter R 5–A on approach for landing on Cajon Ridge, with nose up to reduce forward speed. Altitude, 3,800 feet above sea level.

This small two-place craft was soon found to be inadequate in pay-load capacity and altitude range for Forest Service work. Tests on the Sikorsky R 5–A equipped with standard rotor blades were initiated at March Field in April 1946. Considerable was learned about helicopter operation in mountainous areas with this ship. But the R 5–A also lacked the ability to carry the necessary pay load in spot landings and take-offs at elevations over 3,000 feet with summer temperatures.

In July 1946, a set of new high lift blades was furnished the project by Sikorsky. Although the performance data given below are primarily for the R 5–A with these high lift blades, certain data for the same helicopter with standard blades are shown for comparative purposes. All data would apply to the R 5–D or S–51 models when equipped with the same blades.

Effect of Temperature

All aircraft performance specifications and all performance data included in this article are for N. A. C. A. Standard Air. Altitudes under N. A. C. A. Standard Air conditions are called density altitudes.

Table 1 may be used for converting measured elevations or altitudes to density altitudes (N. A. C. A. Standard Air) or vice versa. Since no correction for variation in barometric pressure at sea level is made in this table, precision is to the nearest 150 feet. Example: A landing spot has a measured elevation of 7,000 feet as determined from the topographic map. Weather records show that during the summer, temperatures at this landing spot may often reach 90° F. From table 1 the approximate density altitude at this landing spot would be 10,700 feet at 90° F. The helicopter would perform under these conditions as though it were at an altitude of 10,700 feet. Interpolation of values given in the table may be necessary in many cases.

TABLE 1.—*Approximate density altitude (N. A. C. A. Standard Air)*[1]

Measured elevation above sea level (feet)	Density altitude when air temperature at actual elevation is—					
	30° F.	45° F.	60° F.	75° F.	90° F.	105° F.
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
1,000	−500	400	1, 200	2, 200	3, 200	4, 100
2,000	700	1, 500	2, 400	3, 500	4, 400	5, 300
3,000	1, 900	2, 900	3, 700	4, 700	5, 700	6, 600
4,000	3, 200	4, 100	5, 000	6, 000	6, 900	7, 800
5,000	4, 500	5, 400	6, 300	7, 300	8, 200	9, 000
6,000	5, 700	6, 600	7, 500	8, 500	9, 400	10, 300
7,000	7, 000	7, 800	8, 800	9, 800	10, 700	11, 500
8,000	8, 300	9, 100	10, 000	11, 000	12, 000	12, 800

---

[1] Assuming a barometric pressure at sea level of 29.92″ Hg.

Specifications and Performance

The specifications and performance of the Sikorsky R–5 (S–51) helicopter are given in the following tabulation. Manufacturer's data were obtained from tests performed for C. A. A. All altitudes given are density altitudes under N. A. C. A. Standard Air conditions.

Specifications

Weight:	
Gross, Model R 5–A	4, 900 pounds
Model S–51	4, 985 pounds
Empty, Model R 5–A with standard equipment	3, 760 pounds
Empty, Model R 5–A or S–51 stripped of nonessential covering and auxiliary equipment	3, 500 pounds
Seating capacity:	
R 5–A	1 passenger and 1 pilot.
R 5–D and S–51	3 passengers and 1 pilot.
Fuel capacity	100 gallons.
Oil capacity	8 gallons.
Engine: Pratt-Whitney Wasp Junior R–985–AN–5.	
Normal rating	450 b. hp. at 2,300 r. p. m. at sea level.
Take-off rating	450 b. hp. at 2,300 r. p. m. at 2,300 feet altitude.
Fuel	Grade 91 octane.
Oil	Grade SAE 60 Summer, SAE 50 Winter.
Dimensions:	
Length, over-all (blades extended)	58′ 0½″
Length, over-all (blades removed)	44′ 11½″
Height, over-all	12′ 11″
Main rotor diameter	48′ 0″

Specifications—Continued

Dimensions—Continued

Tail rotor diameter	8′ 5″
Alighting gear tread	12′ 0″
Cabin width, pilot's (S–51)	4′ 5″
Cabin width, passengers' (S–51)	5′ 2″
Cabin height, floor to ceiling	4′ 5½″

Performance

	High lift blades	*Standard blades*
Gross weight, 4,900 pounds:		
Maximum speed placarded by C. A. A. (3,900 ft.)	103 m. p. h	103 m. p. h.
Cruising speed at 65 percent b. hp. at sea level	80 m. p. h	80 m. p. h.
Minimum flying speed (up to hovering ceiling)	0 m. p. h	0 m. p. h.
Fuel consumption (cruising), approx	28 gal./hr	28 gal./hr.
Gross weight, 4,985 pounds:		
Maximum rate of climb at sea level	1,370 ft./min	1,230 ft./min.
Hovering ceiling without ground effect	6,200 ft	3,200 ft.
Hovering ceiling with ground effect	8,000 ft	6,800 ft.
Absolute ceiling	17,250 ft	14,900 ft.
Gross weight, 5,180 pounds: Ceiling	16,200 ft	11,000 ft.

The data shown in tables 2 and 3 were obtained from actual tests on the Angeles and San Bernardino National Forests. Successful landings and take-offs were made in mountain terrain with the loads shown at the altitude indicated, except that no tests were run at density altitudes greater than 9,300 ft.

The net pay load shown was computed as the difference between the gross weight of the machine and the weight of the stripped machine when serviced for a 125-mile operating range as shown in table 2.

TABLE 2.—*Maximum gross weight and net pay load for spot landing and take-off at various density altitudes* [1]

Dimensions—Continued Density altitude, N. A. C. A. Standard Air (feet)	Gross weight		Net paid load	
	High lift blades	Standard blades	High lift blades	Standard blades
	Pounds	*Pounds*	*Pounds*	*Pounds*
1,000	5, 600+	5, 460	1, 500	1, 360
2,000	5, 600+	5, 300	1, 500	1, 200
3,000	5, 520	5, 140	1, 420	1, 040
4,000	5, 380	4, 980	1, 280	880
5,000	5, 250	4, 820	1, 150	720
6,000	5, 110	4, 660	1, 010	560
7,000	4, 970	4, 510	870	410
8,000	4, 830	4, 340	730	240
9,000	4, 700	4, 190	600	90
10,000	4, 560		460	
11,000	4, 420		320	
12,000	4, 280		180	

[1] Wind velocity at 20 feet above landing spot, 0 to 5 m. p. h.; full throttle; engine speed, 2,300 r. p. m., except 2,400 r. p. m. while breaking ground and approaching for landing. Minimum clearance while hovering at 2,300 r. p. m. and full throttle, 3 feet.

It should be noted that while the helicopter is capable of operating successfully at a gross weight considerably in excess of 4,900 pounds, this is forbidden in actual operations as C. A. A. does not permit loads in excess of the designed gross.

For practical purposes, therefore, it is necessary to reduce the fuel load in order to carry the maximum pay load and still keep within the designed gross weight. This may be accomplished as follows:

	Pounds
Weight, empty (stripped)	3,500
Pilot (1)	170
Residual fuel and oil	30
Oil (6.7 gallons)	50
Fuel (58.3 gallons for 1 hour 33 minutes, including 15 gallons reserve)—sufficient for 125-mile range	350
Operating weight (no pay load)	4,100
Pay load	800
Gross weight	4,900

It may be seen then from table 2, that the maximum density altitude to which the maximum pay load may be carried is 7,500 feet for the high lift blades, and 4,500 feet for the standard blades.

While the machine may not be used to carry the loads it is capable of handling at the lower altitudes, it is obvious that the load reduction will result in progressively increased performance as the altitude is decreased. This is shown in terms of rate of climb in table 3.

Table 3.—*Rate of climb of helicopter with high lift blades* [1]

Density altitude (feet)	Rate of climb	Manifold pressure	Density altitude (feet)	Rate of climb	Manifold pressure
	Feet per minute	*Inches Hg*		*Feet per minute*	*Inches Hg*
3,000	1,210	35	8,000	600	30½
4,000	1,040	35	9,000	520	29
5,000	900	34	10,000	440	28
6,000	800	33	11,000	350	27
7,000	700	31½	12,000	270	26

[1] Gross weight, 4,900 pounds; engine, 2,300 r. p. m.; air speed, 60 m. p. h. Best rate of climb speed is approximately 50 m. p. h.

Hovering

Hovering is one of the most important types of operation. Theoretically, a helicopter can climb vertically to its hovering ceiling (without ground effect). This is not practical, however, as it places undue strain on ship and engine, and pilots find it easier to climb with forward speed. Hovering between 30 and 300 feet above the ground is considered hazardous, since in case of engine failure, a successful autorotation landing may not be made. The hovering ceiling (without ground effect) is the maximum density altitude at which the helicopter can maintain altitude with zero air speed.

When hovering close to the ground (12 feet wheel clearance for R–5 or S–51), an air cushion is built up between the rotor and the ground. This cushion provides additional lift and the operation is called hovering *with* ground effect. The hovering ceiling with ground effect is slightly higher than the maximum density altitude at which spot landing and take-off with a given gross weight can be made with normal power settings.

Vertical descents are not normally made except within the ground cushion.

Landing and Take-Off

Normal landing and take-off paths for the helicopter are similar to those for a light airplane, except no run on the ground is required for the helicopter and the helicopter climbs and descends more steeply.

R 5–A at moment of final hovering before landing on Cajon Ridge, Calif.

Specifications for Spot Landing Areas for R–5 (S–51) Helicopter With High Lift Blades

1. Landing-area requirements for spot landings and take-offs of the helicopter are the same for all elevations. Terrain should slope gently away from the landing spot for about 500 feet. Landing areas located on ridge-top knolls are most desirable. The ridge-top location is preferred to one in a canyon because normally less clearing is required, and in take-offs, flying speed may be more quickly gained by losing altitude. Also, ridge-top landing areas require little maintenance and special drainage.

2. Landing areas in accordance with these specifications are considered safe for normal spot landings and take-offs, but if the area is to be used for autorotation landing the obstacle height should be lowered 25 feet from that shown in the tabulation below.

3. The minimum landing spot should be 200 feet in diameter, level and graded.

4. Clearing for landing approach and take-off paths should be located so helicopters can land and take off into the wind. Satisfactory cross-wind landings and take-offs are difficult when wind is gusty.

Distance from center of landing spot	Maximum permissible height above landing spot of obstacles in take-off and landing approach paths
Feet	*Feet*
100	0
200	3
300	14
400	20
500	47
600	63
700	79

Although exceptionally large and high obstacles between 700 and 2,000 feet from the landing spot and along the take-off or landing approach path are undesirable, clearing beyond 700 feet is unnecessary since the helicopter can take off or land in a continuous turn over a 700-foot diameter area.

With maximum gross weights, the helicopter travels on take-off from 75 to 100 feet on the ground cushion before it gains sufficient speed to leave the cushion, and climb with translational lift. Upon normal approach for landing its speed is checked and a ground cushion picked up as it comes within 200 to 300 feet of the landing spot. The helicopter is then eased over the spot and let down from hovering to the ground.

If the helicopter is equipped with high lift blades, suitable landing gear and brakes, running landings and take-off could be made with full design gross weight (4,900 pounds) up to density altitudes of 10,000 feet. This would require a landing strip, but a much shorter one than required for conventional airplanes.

First Use of Helicopter in Fire Suppression

Although it has been verbally reported that previous use has been made of a helicopter to patrol fires in Florida swamp lands, its first recorded use on a going fire by the Forest Service, as part of the scouting and transportation facilities, is now part of the record of the Castaic Fire, Angeles National Forest, Region 5.

On the third day of the fire, September 9, 1946, a Sikorsky R 5–A with standard blades, furnished by the 62d AAF Base Unit, March Field Detachment, and piloted by Lts. Chuddars and Frost, arrived at the fire just in time to carry George Reynolds, Angeles Forest Engineer, on a scouting and mapping expedition of an 800-acre break-over into the rugged and inaccessible Red Rock Mountain area. Within less than three quarters of an hour the helicopter was landed in a 200-foot clearing at the fire camp (abandoned Castaic CCC Camp) in the bottom of Castaic Canyon, and an unusually detailed and accurate map of the fire situation was delivered to the fire boss. With any other means, including conventional aircraft, much more time would have been required and considerable important detail could not have been obtained.

Several additional flights were made from the fire camp during the remainder of the afternoon, and information continued to be reported from the helicopter by radio. Because of high obstacles adjacent to three sides of the landing spot, all landings and take-offs were made from one side quartering into the wind.

On the morning of September 10, work in establishing a fly camp on the summit near Red Rock Mountain was begun. This camp was to be dropped in and supplied by air. Elevation was 4,000 feet (density altitude approximately 7,000 feet). Since the helicopter was not stripped and not equipped with the new high lift blades, it could not land with a reasonable pay load at the dropping area. However, Lieutenant Frost and B. O. Hughes (Assistant Regional Forester, Region 5) succeeded in delivering cargo which was released free fall close to the ground and at speeds under 15 miles per hour. Later in the day, Lieutenants Frost and Reynolds dropped clean socks literally at the feet of the weary firefighters.

Throughout September 10, helicopter reconnaissance of the perimeter of the break-over continued until all hot spots were manned. During all flights the helicopter was subjected to severe gustiness, updrafts, and downdrafts. Reports from pilots and passengers indicate that the helicopter was far less affected by these severe air currents than the twin-motored Beechcraft (AT–11) used in cargo dropping for the same fly camp.

Helicopter vs. Conventional Aircraft in Cargo Delivery

During the period of September 10 and 11, on the same Castaic Fire, 8,361 pounds of cargo (including chute and packaging) were dropped by the twin-motored Beechcraft (AT–11), which had been modified especially for this work. It required 9 flights averaging over 40 minutes each to deliver this cargo. From 5 to 7 passes of the dropping area were made to discharge each load. The average load was 929 pounds. It is estimated that approximately 800 pounds of each load consisted of equipment and supplies.

It is interesting to note the probable relative efficiency of a helicopter in this operation. Since the dropping area was a natural ridge top helicopter landing spot with density altitude of 7,000 feet, we find from table 2 that a stripped version of the R–5 (or S–51) with high lift blades could have easily carried 800 pounds of equipment and supplies on each flight and landed at the dropping area. By moving the air supply point from Newhall airport to the fire camp (Castaic CCC Camp), the flying time plus unloading time for the helicopter would have been from 15 to 20 minutes per 800 pound load. Besides the total time saved in delivering the supplies and in flying time costs, a considerable saving would have been made in packaging, cargo chutes, and preventing losses. At least five chutes did not open or failed during this operation, and equipment dropped free fall scattered considerably down the steep slopes.

Returning the fly camp equipment to a truck head is a costly pack animal project. A suitable helicopter could have transported it back to the main fire camp in approximately four 20-minute round trips. The transportation of men and supplies by suitable helicopter to the fire line is not discussed here. Such possibilities, however, were unlimited on more than 75 percent of the fire line for this particular fire.

Future of Helicopters in Forest Work

Although the information given in this article is insufficient for complete planning in the use of the helicopter, it is hoped that it will be inspiring to those who have long hoped for a successful machine. There is no doubt that there will soon be available helicopters suitable for forest fire control activities. Helicopters that will carry an adequate pay-load to the elevations with which we are concerned, and perform satisfactorily, have been field tested. It is expected that the several mechanical "bugs" now hindering the continuous operation of these ships will soon be eliminated. When this is done, the helicopter for forest-fire work will be ready to serve you.

Novel Method of Fire Area Measurement.—Region 5 reports a very ingenious method of measuring the size of a fire developed by one of their pilots. While flying across the fire at 120 miles per hour the observer presses his face against the window watching the trailing edge of the wing strut. As the strut crosses into the burn the observer calls "now" and another passenger begins timing with the second hand of his watch. When the other edge of the fire is reached the observer again calls "now" and the timing is stopped. Two flights are made in each direction to compensate for wind. In a case which was cited the data obtained was an average of 12 seconds one way and 6 seconds on the cross trip. With the speed of the plane at 120 miles per hour, 2 miles per minute, or 2.67 chains per second, it was determined that the fire was 32 chains long and 16 chains in average width. This indicated that the fire had spread over an area of 51 acres.

PRESCRIBED BURNING IN THE FLORIDA FLATWOODS

C. A. Bickford[1] and L. S. Newcomb[2]
U. S. Forest Service

This discussion of prescribed burning is based on experience and studies of the use of fire as a tool in the elimination of hazardous fuels in the longleaf-slash pine forests of the flatwoods section of Georgia and Florida. It does not cover other uses of fire in the silvicultural control of diseases in pure longleaf pine and other southern forest types. Most of the practices described will, however, be found applicable to other types of prescribed burning.

By definition prescribed burning is a distinctly technical measure and a potentially dangerous tool. Mr. Arthur W. Hartman, Chief of Fire Control in the Southern Region, sounds a note of caution when he says this employment of burning is "the application of fire to land under such conditions of weather, soil moisture, time of day, and other factors as presumably will result in the intensity of heat and spread required to accomplish specific silvicultural, wildlife, grazing, or fire hazard reduction purposes." Consequently, fires set for any other purposes or set without expert knowledge of fire behavior under existing conditions of weather, soil moisture, time of day, probable wind, etc., are definitely to be avoided. Uninformed and misguided efforts to burn are almost certain to produce disastrous results.

Successful fire protection in the long-leaf-slash pine forests of the southeastern flatwoods markedly changes the composition of the stand. Under protection, slash pine, instead of remaining confined to ponds and swamp margins, reproduces vigorously and invades drier sites formerly occupied almost exclusively by open stands of longleaf pine. The stand is thus converted from nearly pure longleaf pine to one in which slash pine predominates. This change in composition is sought and welcomed by most owners and operators of forest land because of the rapid growth of slash pine and its high value for naval stores and other products.

Unfortunately, increase in fire hazard accompanies this beneficial conversion to slash pine. Under fire exclusion the grass roughs become heavy. Needles and twigs add to the inflammability, while the gallberry and palmetto undergrowth increases in size and density. Conditions often become particularly hazardous in dense stands of slash pine 10 to 15 years of age, where dead needles may be draped over the high gallberry undergrowth and the lower dead branches in an almost continuous screen from the ground to the living crown 15 to 20 feet above.

When a fire starts in stands unburned 10 or more years it spreads rapidly and is hard to control. Such fires often cause extensive and severe damage and become so much of a threat to the landowner that he is likely to give up the idea of growing timber on his land.

---

[1] Forester, Northeastern Forest Experiment Station (formerly of Southern Forest Experiment Station).

[2] Forester, Naval Stores Conservation Program (formerly District Ranger, Osceola National Forest).

To decrease the threat of such fires, many foresters and landowners in this section have resorted to prescribed burning of accumulated fuels at intervals under carefully selected weather conditions. Slash pine about 6 feet in height and longleaf over one year in age can stand slow-burning prescribed fires during the dormant season. Experience demonstrates that burns carefully planned and executed in this season may temporarily eliminate the hazard of accumulated fuels without serious injury to the timber stand.

Osceola National Forest, Florida. Dense slash pine 15 years of age. Note dead needles draped over gallberry undergrowth and dead lower limbs. Wildfire in such a stand almost always results in a complete kill.

Prescribed burning to reduce fire hazard affects fire prevention, detection, suppression, and other fire control activities. Its justification depends on reducing the total costs of fire control in which incidental damage caused by the the burning is considered an item of cost.

This paper describes methods of prescribed burning developed and used on the Osceola National Forest in northeast Florida, a tract of 168,000 acres typical of managed forests in the southeastern flatwoods. On this area fuel accumulated in dangerous quantities for 15 years, during which time the presence of small slash pine throughout the forest made fire treatments impractical. As the slash pine began to reach a size where damage from slow-burning fire would be minor, trial burns were made. On the basis of these trials and other observations, plans were laid in 1943 to prescribe-burn approximately 100,000 acres of longleaf-slash pine in the following 3 years.

In the first year 39,130 acres were treated at a cost of 7.9 cents per acre, of which 0.7 cent was for planning, 3.2 cents for preparations (chiefly plowing fire lines), and 4.0 cents were direct costs of burning. Costs the second year for 33,100 acres were 6.6 cents per acre treated; planning 0.7 cent, plowing 3.7 cents, and direct cost 2.2 cents.

Damage from the first year's operations was estimated at 31.4 cents per acre treated, and in the second year at 8.7 cents. Because of general drouth and few periods of ideal burning weather, the damages sustained during the first year were greater than anticipated. Damages during the second year were reduced somewhat by the added skill and experience of the men conducting the work but primarily by the more favorable ground water and weather conditions prevailing. By treating a maximum area during good burning years and a minimum during unfavorable years, future damage should be held to 8 cents per acre or less.

Forest managers throughout the South, who after careful analysis determine that the use of fire for some specific purpose is desirable, will find the methods used on the Osceola National Forest helpful in planning and organizing their prescribed burning.

Methods Used

Prescribed burning, to give maximum benefits at the least cost and damage, involves the following steps: Analysis, planning, preparation, burning, and appraisal. Each step is important and necessary.

Analysis

To arrive at a satisfactory decision whether to use fire, an analysis of forest conditions must be made which will permit a sound comparison between the probable costs and damage and the expected benefits. Direct costs can be satisfactorily determined from data such as given here and from similar operations in the same forest type.

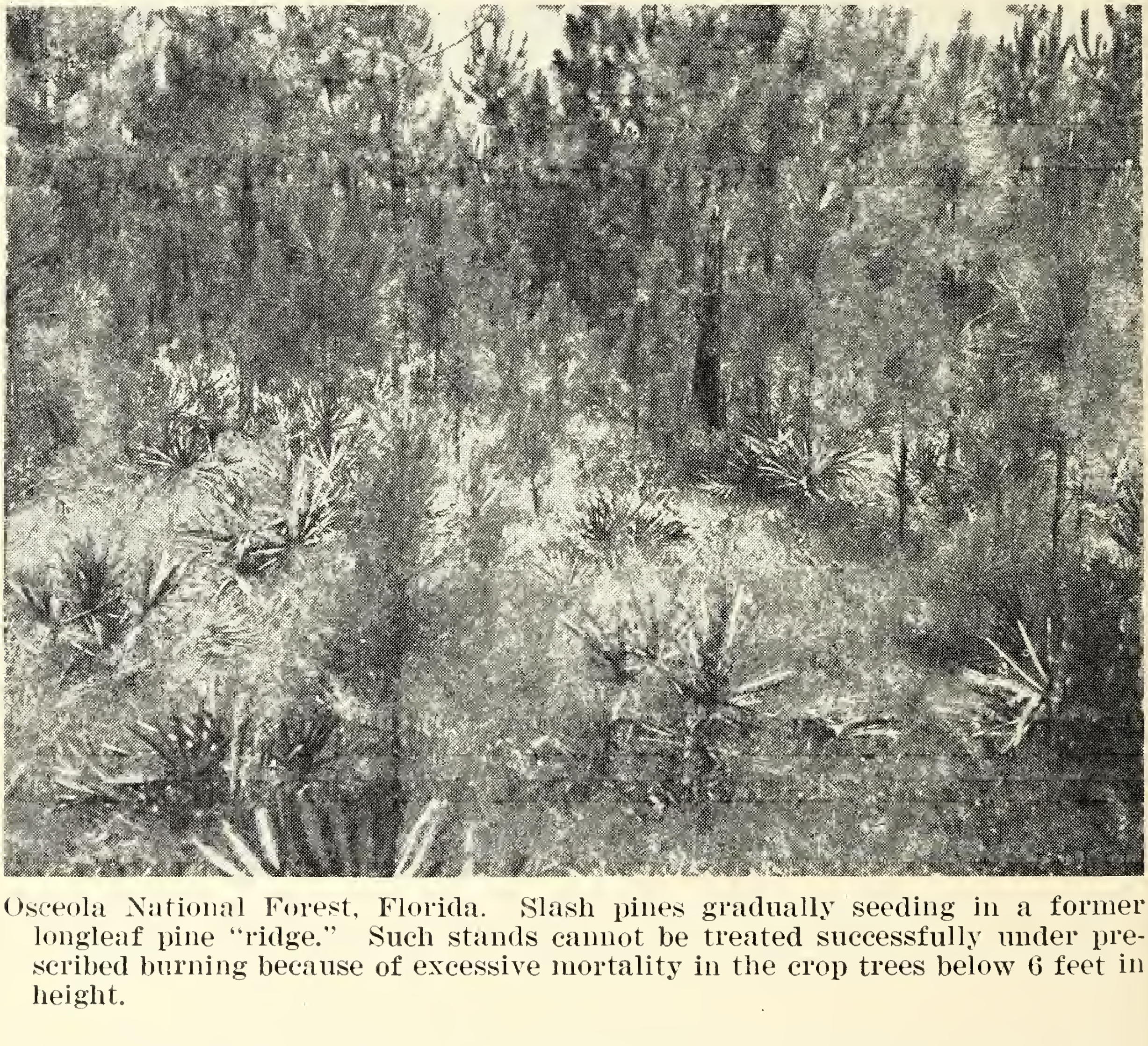
In the flatwoods, benefits are mainly in the reduction of hazard and the consequent reduction in the possibility of large and destructive fires. Damage will depend to some extent on the weather during the burning season, but most of all on the training, skill, and experience of the personnel. Although prescribed burning in this section will be most important to fire protection, its influence on grazing, silviculture, logging, game, turpentining, and other forms of land use must be carefully considered. The advantages and disadvantages of the practice vary widely from property to property and no simple and precise method of evaluation can be suggested. The practice should be undertaken, however, only after a careful analysis has convinced the owner of the need or desirability of the practice on all or part of his holdings.

Once he has analyzed his property and decided to burn, the owner must determine which areas to treat. Areas burned should ordinarily be distributed so as to serve as temporary firebreaks. Prescribed burning of areas of high fire incidence is a double gain, for the areas not only become safe themselves but also act as firebreaks. The detailed location of burning units should be decided only after field examination as described in the following section.

Planning

The prescription or plan is a most important phase of prescribed burning, distinguishing it from unorganized and often destructive use of fire. The prescription is prepared in the field at the time of examination. It specifies when and how to spread fire to achieve the greatest benefit.

The first step in planning is to make a field examination to secure the necessary data. On the Osceola National Forest experienced and responsible forest guards made the examinations under the direction of the District Ranger. In planning the use of fire on extensive areas, maps are prepared to show natural fire barriers, fire line locations, burning direction, areas to be excluded, usable roads and trails, and other useful information. The examiners on the Osceola used aerial photographs for base maps on which to record such information. On small properties detailed examination and mapping may be unnecessary.



Osceola National Forest, Florida. Slash pines gradually seeding in a former longleaf pine "ridge." Such stands cannot be treated successfully under prescribed burning because of excessive mortality in the crop trees below 6 feet in height.

The size, abundance, and distribution of crop trees[3] determine where and how fire can be used. Small slash pine is easily fire-killed and extensive areas of slash pine crop trees under 6 feet high should not be burned. When the crop trees are slash pine 1 to 3 inches in diameter at breast height, or longleaf from 1 year old to 3 inches in diameter at breast height, a backfire, that is, fire set to spread only against the wind, in the dormant season under proper weather conditions may be safely used. With crop trees 4 inches in diameter at breast height, or more, a flankfire is safe. A flankfire, set to burn at right angles to the wind, spreads faster and burns hotter than a backfire. Flankfires in such stands are cheaper to use and generally cause less damage than backfires. In the Florida-Georgia flatwoods, where young slash pine is common, a backfire is the usual prescription. On the Osceola, many stands otherwise suited for flankfire contain scattered groups of slash pine crop trees 1 to 3 inches in diameter at breast height, usually making it necessary to prescribe a backfire.

---

[3] In this work, the best trees at an average spacing of 10 feet were considered crop trees and smaller intermediate or suppressed trees were disregarded in planning the burning and in evaluating the results.

Small patches of slash pine crop trees under 6 feet high are often found in stands otherwise suited for burning. Whether to burn them with the rest of the stand or plow around them and exclude fire depends on the size of the patch, the number of small slash pine crop trees it contains, and its nearness to the fire lines needed to burn the rest of the stand. The tabulation below shows the smallest size patch found worth excluding on the Osceola National Forest. Smaller areas were often excluded when only a slight change was needed in the location of a plowed line.

Maximum area to exclude	Slash pine crop trees per acre under 6 feet tall
Acres	*Number*
6	50
5	70
4	95
3	135

The prescription first specifies type of fire, for all other steps depend on it. It then recommends preparatory work, mainly plowed lines to control the spread of the fire. Exterior barriers must be provided for all burning units; roads and streams should be used where possible to reduce plowing cost. Flankfire requires interior parallel lines about one-half mile apart to avoid too long a flank. Backfire requires a similar series of parallel lines close enough together that the area between them will burn out in the burning period. Backfire spreads about 1 foot per minute, and so 600 feet is the maximum distance between such lines unless more than 8 to 10 hours burning is planned. Since northerly winds are least variable, these interior lines are usually plowed in an east-west direction.

For most purposes the season for using fire is the late fall and winter after the first frost (about November 15) and before the beginning of needle growth in the spring. Prescribed burning should be completed before the start of the spring fire season, about March 1. It is desirable to burn as much as possible in wet years when the ponds are full of water. Day burning is easy to supervise and to do correctly, but night burning is necessary when minimum fire intensity is required. Plan to burn only when constant wind direction is forecast. As wind shifts and break-overs are the greatest source of damage, good burning conditions are found when there is a 3- to 10-mile northerly wind in clear weather immediately after rain. Wind direction is commonly variable in the unsettled weather previous to rainfall. Wind shifts are also likely around noon and sunset. On the Osceola the northerly winds which prevailed 1 to 3 days after rains were the most reliable.

The prescription should also cover the size of crew and equipment needed. Motor equipment is used mainly to plow lines and to transport men and tools. Spreading and mop-up tools are needed for the burning job, and ample fire-suppression tools should be available in case of break-overs. Crew size is influenced principally by considerations of cost and safety. It is seldom safe to attempt prescribed burning with fewer than 3 men. Reasonable cost in relation to benefits requires that at least 10 acres be treated per man-hour; thus a crew of 5, including the leader, should treat at least 400 acres in an 8-hour day. Such a crew on the Osceola National Forest burned 500 to 1,000 acres per day (12½ to 25 acres per man-hour) setting as much as 10 miles of backfire and providing the needed mop-up and patrol. This crew was large enough to vary duties to meet particular fuel and weather conditions. At night, with no patrol, smaller crews may be superior, while if mop-up is needed it is better to have extra men than to take some away from the work of spreading fire. Continuous day and night burning can be used, if relief crews are available, to lower costs under exceptionally favorable conditions of weather, fuel, and stand. Good prescribed burning requires that crews be relieved after 8 hours of work.

All preliminaries and plans for burning should be completed by early fall to eliminate haste and consequent poor results.

Preparation

Preparation for burning consists mainly in plowing the lines provided for in the plan. Enough lines are plowed in advance to permit choosing one of several units on the burning day; yet, to prevent fallen needles and leaves from weakening the lines, plowing ordinarily should precede burning by not more than two weeks. Lines should be carefully located to minimize break-overs from hazardous fuels such as snags and thickets of gallberry. A two-disk plow such as the Mathis, drawn by a light tractor, will prepare a line about 6 feet wide at a cost of about $3.25 per mile. With several hundred miles of line to plow, such equipment is indispensable. Plowing and burning in one operation is inefficient since a line can be fired 3 times as fast as it can be plowed.

Burning crews should be selected and trained well before the start of operations. The plow operator needs to know how to read maps and aerial photographs and where lines should be located as well as how to operate and service his plow and tractor. Crewmen must be taught how to fire in relation to plowed line and hazardous fuels. Mop-up standards, changes to meet wind shifts, provisions in emergencies, etc., should be clearly understood by all. This training should be continued as long as necessary after burning starts. The continuity afforded by having the crew foreman examine, map, plan, and plow is desirable but seldom possible.

Reliable weather forecasts improve the quality of burning, and arrangements should be made to receive daily forecasts of wind direction and velocity, relative humidity, precipitation, and general state of the weather. Forecasts twice daily at 12-hour periods are best: the first should be received by 8 a. m., before departure of the work crews, and the second before the usual quitting time.

Burning

Each day during the burning season the manager, guided by weather forecasts and experience, decides whether or not to burn and selects the best unit for conditions expected. With favorable weather low costs are achieved by spreading fire rapidly to increase area burned per man-hour.

To complete the burning job, the area should be mopped-up to prevent break-overs. The extent of mop-up will depend on the amount of dangerous fuels and on weather conditions.

Appraisal

Appraisal following burning may consist simply of field checks, or it may be a careful evaluation of both injury and benefits for the whole area. When crowns are not scorched above half their height, damage is minor: a few small trees are killed and growth on others is slightly reduced for a year or two. Scorching more than four-fifths of the crown results in excessive mortality and a sharp temporary reduction in growth rate of the survivors.

Recommendations

Prescribed burning methods used on the Osceola National Forest have been briefly described; the most important suggestions follow:

1. Use fire only when analysis reveals benefits should clearly exceed cost and damage.
2. Correlate prescribed burning with silviculture, grazing, game, crops, logging, turpentining, etc.
3. Prepare in advance (examine, map, plan, plow, etc.) so as to be ready when burning conditions are right.
4. Arrange for weather forecasts, especially of wind direction. A steady wind during the 8 to 10 hours required to burn a unit is of first importance in minimizing cost and damage; burn only when a constant direction is forecast for at least 12 hours.
5. Reduce costs when burning conditions are especially favorable by: (1) spreading backfire rapidly to have 10 or more miles burning at one time, and (2) using relief crews to take full advantage of favorable burning weather.
6. A competent crew is essential; it should be small and composed of reliable local men experienced in fire behavior and control.
7. The forester, to achieve efficient and successful prescribed burning, must use his intelligence, courage, patience, and determination.

OUTLINE FOR ANALYSIS OF FIRE PREVENTION ACTION AS APPLIED TO A PARTICULAR FIRE

All experienced fire control men agree that the most successful fire control job of all is the fire that was prevented from starting. We all give lip service and routine support to preventing fires, but too often we do not get down to cases and carry through on systematic plans and skillful application of lines of action to get real solutions. We need to cultivate the habit of regarding each preventable fire as a challenge to our resourcefulness and as a blot on our record. It is a game worthy of our best talent. The best solution often calls for more head work than figuring out the "who done it" in Sherlock Holmes style. "Who" is only one step. The even bigger job to every land manager is to arrive at "It won't happen here." That requires lots of team work!

In California, a great deal of thought and planning is now being given to the problem of arriving at this goal. In the process, Region 5 has devised an outline to guide the preliminary process of making a systematic analysis. If well carried through on a series of fires, one at a time, a sound plan of action geared to the local situation ought to evolve naturally. Here is their chart. Try it out, then see if you can devise a better one!

CAUSE

Get detailed facts of this. Seek basic cause that led to statistical cause.

- I. Preventable
  - A. What known fire prevention techniques were applied in this case?
    - 1. How identify hazard.
    - 2. Physical methods for abatement of hazard.
    - 3. How approach agency or person responsible.
    - 4. How inspire person or agency to undertake abatement.
      - a. Discussion.
      - b. Examples.
      - c. Sample demonstration.
      - d. Cooperative assistance.
    - 5. Enforcement methods possible to insure abatement.
      - a. Punitive measures (shut-down, etc.).
      - b. Cancellation of permit.
      - c. Legal action.
  - B. What is Forest philosophy concerning application techniques?

	a.	b.	c.	d.
1. How do	Supervisor and Staff.	Ranger.	FCAsst.	Guard.
2. What do	Supervisor and Staff.	Ranger.	FCAsst.	Guard.
3. When do	Supervisor and Staff.	Ranger.	FCAsst.	Guard.
4. Who do	Supervisor and Staff.	Ranger.	FCAsst.	Guard.

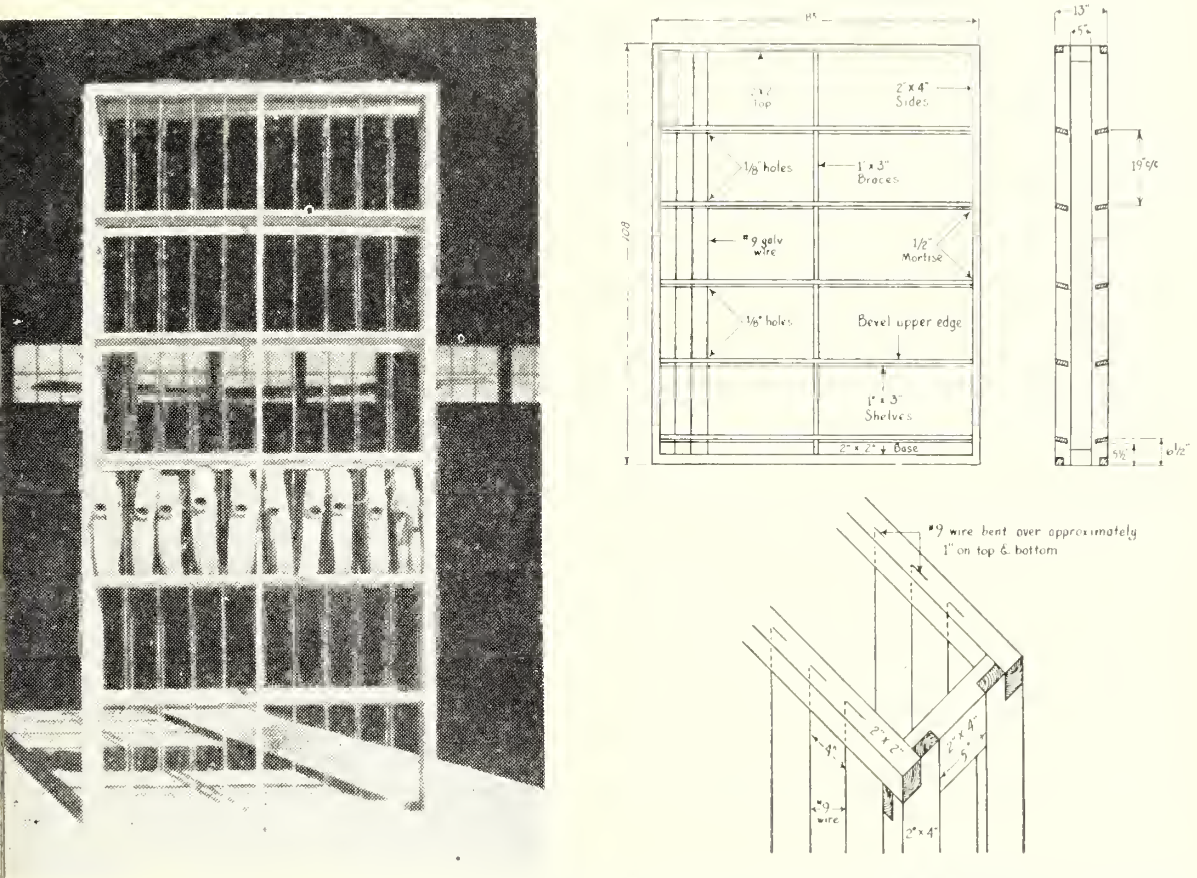
  - C. What actions taken in this case?
    - 1. Identify actions taken in accordance with A and B above.
  - D. Quality of actions taken? — Identify by facts.
    - 1. Positive
    - 2. Casual
    - 3. Negative
  - E. Why did action fail?
    - 1. Follow constructive reasoning in arriving at conclusions.
  - F. How improve future action?
    - 1. Philosophy of responsibilities for action at all levels in B.
    - 2. Approach to agency or person responsible.
    - 3. Inspiration to agency or person responsible.
    - 4. Physical methods of abatement.
    - 5. Techniques, including identification of hazards.
    - 6. Application of enforcement measures.
- II. Nonpreventable Why?

HOSE STORAGE RACK

L. A. Horton

District Ranger, San Bernardino National Forest, U. S. Forest Service

A hose storage rack developed on the Mill Creek ranger district has found favor throughout the San Bernardino National Forest. It permits the maximum amount of storage with the use of the minimum amount of floor space. It also allows the hose to be well ventilated and permits easy removal and replacement of hose.



Storage rack with capacity of 3,000 feet of 1½-inch hose; and diagram of storage rack with capacity of 5,000 feet of 1½-inch hose.

Dimensions may be changed so that a rack may be constructed to fit the available floor space. The photograph shows a rack that has a storage capacity of 3,000 feet of 1½-inch C. J. R. L. hose and occupies a floor space of about 4½ square feet. The rack in the diagram has a capacity of 5,000 feet and occupies 8 square feet of floor space.

The rack is constructed by building two identical units (front and back) and fastening them together with 2- by 4-inch blocking as shown.

Bill of material for a rack of 5,000 feet capacity:

325 feet No. 9 galvanized wire.
4 pieces 2″ x 4″ x 9′ (sides).
1 piece 2″ x 4″ x 5′ (spreader blocking).
4 pieces 2″ x 2″ x 7½′ (top and base).
2 pieces 1″ x 3″ x 9′ (shelving brace).
10 pieces 1″ x 3″ x 7′ (shelves).

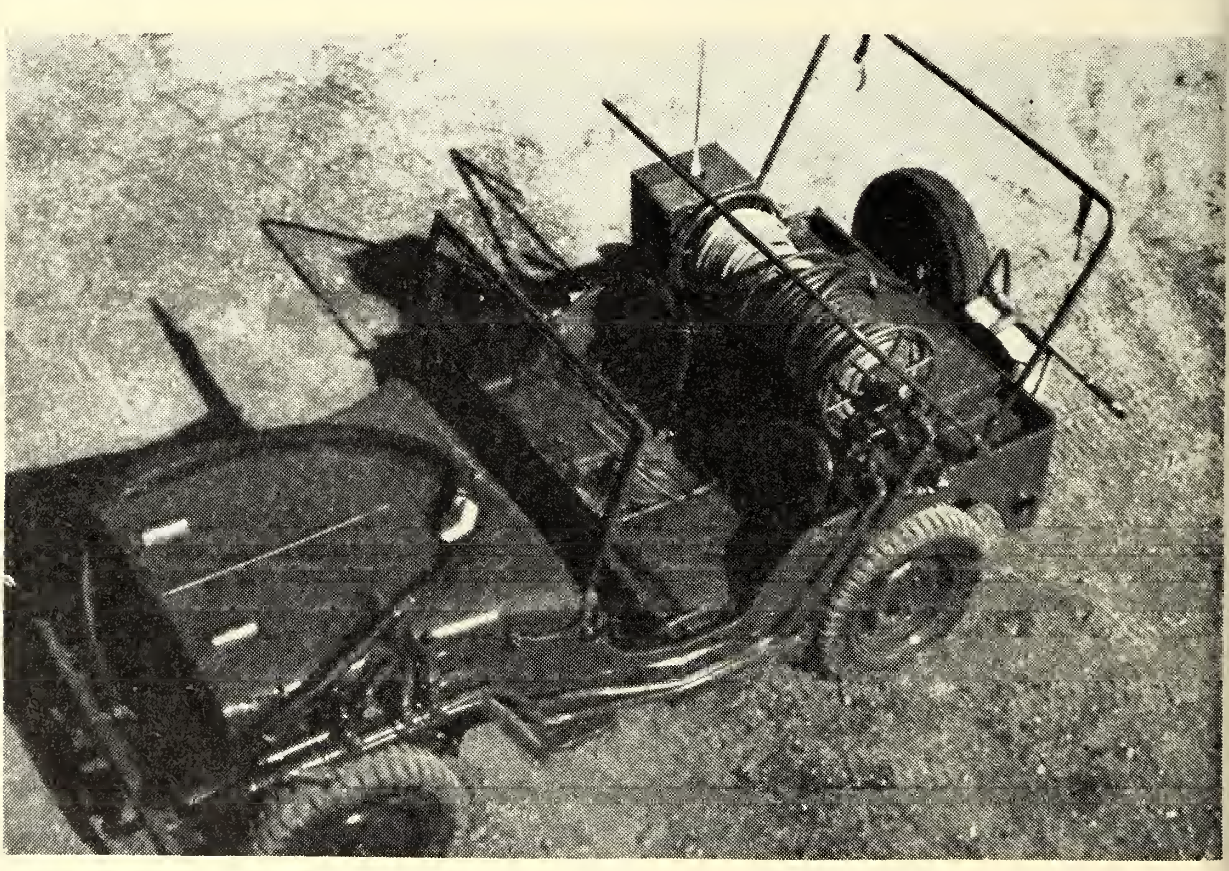
JEEP TANKER

H. M. White

Equipment Engineer, North Pacific Region, U. S. Forest Service

Region 6 has equipped five ¼-ton jeeps with water equipment and assigned them for the use of patrolmen in areas of special hazard. One is equipped with VHF radio and the others will be as soon as additional radios can be obtained.

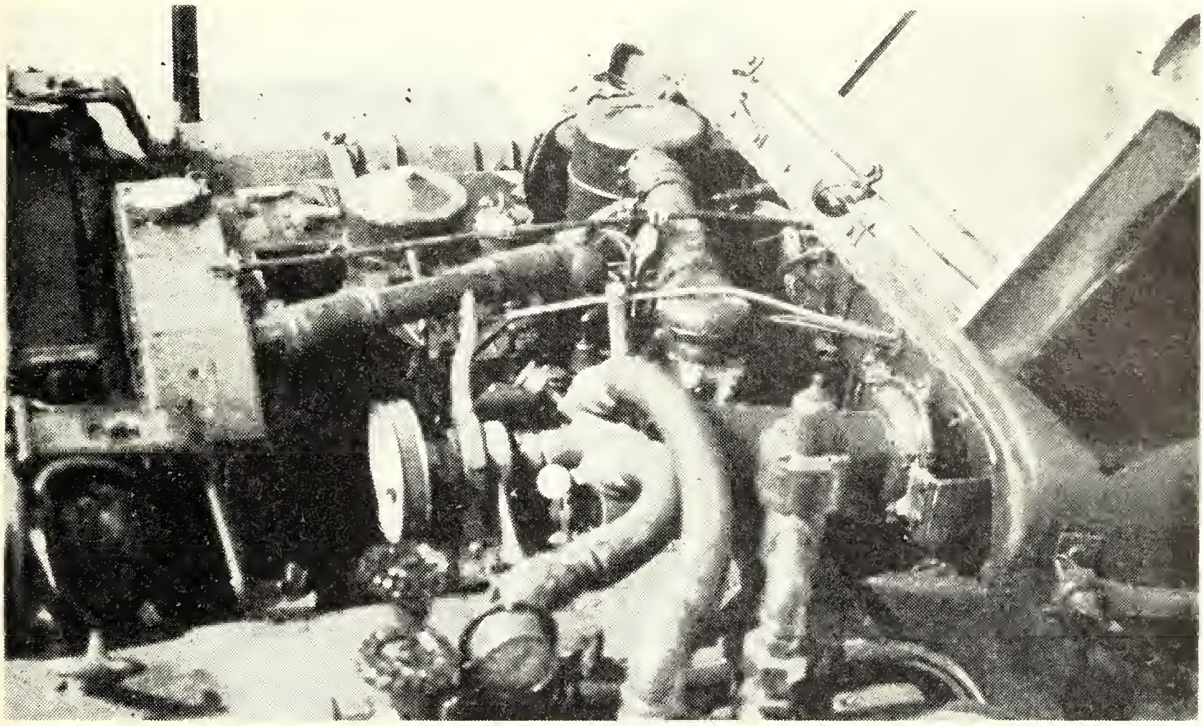
The tank holds 60 gallons and was constructed to fill the space behind the seats. It is rectangular in shape, except that the front side is slanted to conform to the seat backs and the bottom is recessed at each side to fit over the snubber housing. A live reel, carrying 150 feet of ¾-inch garden hose, and a dead reel, with 150 feet of 1-inch rubber-lined hose, are mounted on top of the tank. The KUT-KUR radio is mounted at the end of the dead reel, with the antenna extending through a slit in the top. A canvas flap protects the radio controls when not in use. The microphone is mounted between the reels.



Tanker from above, showing part of tank, hose reels, pipe connections, suction hose, radio, back-pack can and pump, and spare tire.

It seemed better to mount the pump on the inside of the fender than to make the changes that would have been required to mount it on the engine block. The mounting chosen required a change in the lower radiator connection to avoid interference with the fan belt. An intake outlet, with trap, and a 1-inch discharge outlet are provided at the front.

The intake line from the tank and the discharge line to the live reel are made of 1-inch copper pipe, obtained from Navy salvage. The valve arrangement permits filling the tank through its outlet to the pump. The only practicable place to carry the 1-inch suction hose is on the hood, as shown.



Fan-belt pump, with intake and discharge connections, bypass valve, and pressure gage.

The fire equipment carried consists of Pulaski, No. 0 shovel, back-pack can and pump, canvas bucket, 1-gallon canteen, and headlight. The mounting for the back-pack pump was changed after the pictures were taken, because if mounted on the can, as shown, it would be subject to damage. To avoid this, clips were installed on the top of the tank immediately in front of the can and spare tire. The shovel and Pulaski are mounted on the right side of the truck body above the rear wheel. The other articles are carried in the glove compartment, between the seats, and under the right hand seat. A low box between the seats would, no doubt, be convenient for small articles.

Preventing gumming of back-pack pumps.—An excellent preventative for sore and aching arms and gummy back-pack plunger barrels was offered by Fire Control Assistant Davis of the Descanso District, Cleveland National Forest. By cleaning the plungers with solvent and then rubbing them with a bar of soap, they do not become gummy or dirty and, during use, furnish their own lubricant.—REGION 5.

PRELIMINARY REPORT ON AERIAL DETECTION STUDY

R. L. Hand and H. K. Harris
Foresters, Region 1, U. S. Forest Service

This paper reports a study to determine the most economical combination of ground and air detection, based on percent of coverage and frequency of observation. It does not attempt to prove that air detection is or is not superior to ground detection. Such proof would require the study of many additional factors.

Among the various uses of airplanes in fire control work in the western regions, aerial detection must be regarded as something of an anomaly. Although initiated nearly thirty years ago and used more widely than any other type of air service, it is generally regarded as merely an adjunct and in no sense a substitute for the old-fashioned ground or fixed detection system. Other uses of airplanes in fire control, such as the hauling of freight and passengers, cargo dropping, and aerial photographic mapping have been analyzed and compared with the older methods on cost and efficiency basis. So has smoke jumping in recent years. In every instance it has been found that each of these services has paid its way in better results or lower costs under given conditions.

It is our belief that the development of aerial detection has been hampered and delayed because of the traditional attitude toward so-called air patrols, though they have been, it is true, pretty much of a hit-or-miss proposition in the past. There are certain clearly recognizable, but not necessarily inherent difficulties and limitations in spotting fires from an airplane and these seem to have influenced the belief that no common ground could be found on which to base comparisons between air and ground detection. This study was to find a common ground and make comparisons.

Planning the Aerial Fire Control Experiment

In 1945, Region 1 embarked on an aerial fire control experiment involving some two million acres of inaccessible forest land. Ground detectors were reduced to a skeleton force and suppression was handled largely by smoke jumpers within this area, which, because it lies astride the Continental Divide, is usually referred to as the "Continental Area." This forest was selected not because it is especially adapted to the practical use of air detection, but merely to illustrate the principles involved.

In carrying on this experiment it was found that some system on which to base the comparisons was necessary. This resulted in a detailed study, the purpose of which was to determine at what point air detection should be substituted for ground detection on a sound economic basis. The preliminary findings are presented here with the full realization that they are tentative and incomplete. It will require at least several seasons of cautious and painstaking application of the indicated principles on an experimental basis before we are ready for an all-out regional aerial fire control plan.

Standards for Comparison

As a basis for evaluating ground detection, Hornby's detection coverage curves were used. (See "Fire Control Planning in the Northern Rocky Mountain Region" by L. G. Hornby, page 73, fig. 20.) The average of these curves, when projected outward, indicates that in Region 1 approximately 500 lookout stations per million acres would be required to give 100 percent coverage. While absolute, complete coverage even with this number of lookouts is of course theoretical, it is reasonable to expect that a detection force of that intensity would give at least 95 or 96 percent, which for all practical purposes may be regarded as full coverage.

In addition to establishing a fixed point for the maximum degree of coverage, it was necessary to arrive at certain standards of frequency in observation that could be applied to both ground and air detection. Obviously, what we have thought of as constant detection is not constant at all, since no lookout can possibly see all of his visible area all of the time. A ground detector might be expected to spend 15 minutes of each daylight hour in actual observation, more constant observation being too severe a strain on the eyesight of the average individual. To put it in another way, all of the lookout's seen area comes under direct observation once each hour during the daylight period, which, for convenience, has been set at 16 hours per day as a maximum. This is closely in line with common practice in Region 1. The actual frequency is much greater than indicated because of the enormous overlap in visible area. This is equally true in air detection. Frequency of observation, combined with degree of coverage were thus set as the standards to be applied for comparison between air and ground detection.

To establish a curve for air detection that can be directly compared with the ground-detection curve, it was necessary to determine the total hours of flying required to maintain the hourly observation frequency rate over a 16-hour period. This was done in the following manner:

First, sample blocks representing different topographic types were selected from three widely separated areas, and these were profiled to determine flight courses and degrees of coverage obtainable (see A). Flights were projected across the sample areas, and by means of the profiles, seen area was computed for each trip until approximately 100 percent coverage had been obtained. By this means, fixed points could be established upon which to base an air detection curve. Flight time was computed for each trip, using an average ground speed for the slow planes used for present-day detection patrols, and the total applied to the million-acre unit by means of a conversion factor.

In working out the sample units representing different types of terrain, it was determined that from three to five trips, depending upon adaptability of the topography to air detection, would give from 95 to 99.4 percent coverage. Refinements made during later studies indicate that these percentages are conservative. Thus, the number of flying hours required to meet the frequency standard can easily be determined and a curve established that can be compared directly with

Hornby's curves based on the ground lookout system. The profiles were made at 1-mile intervals, approximately across the lines of flight, and from these profiles the final courses and flight altitudes were established to give the maximum coverage with the minimum amount of flying. Fuel types, special risk areas, contributed coverage (that seen from fixed lookouts), and the influence of topography on flying conditions often require adjustments, and these factors can all be given consideration when the profiles are made. Studies are under way at present to refine these "seen areas" by the addition of angle profiles, although it is of course realized that any appreciable degree of refinement must be followed up by adequate provision for the intensity of observation needed—probably requiring two observers on the more intricate courses. The profile method of determining flight courses and altitudes was used in the Continental Area during 1945 and 1946 with apparent success.

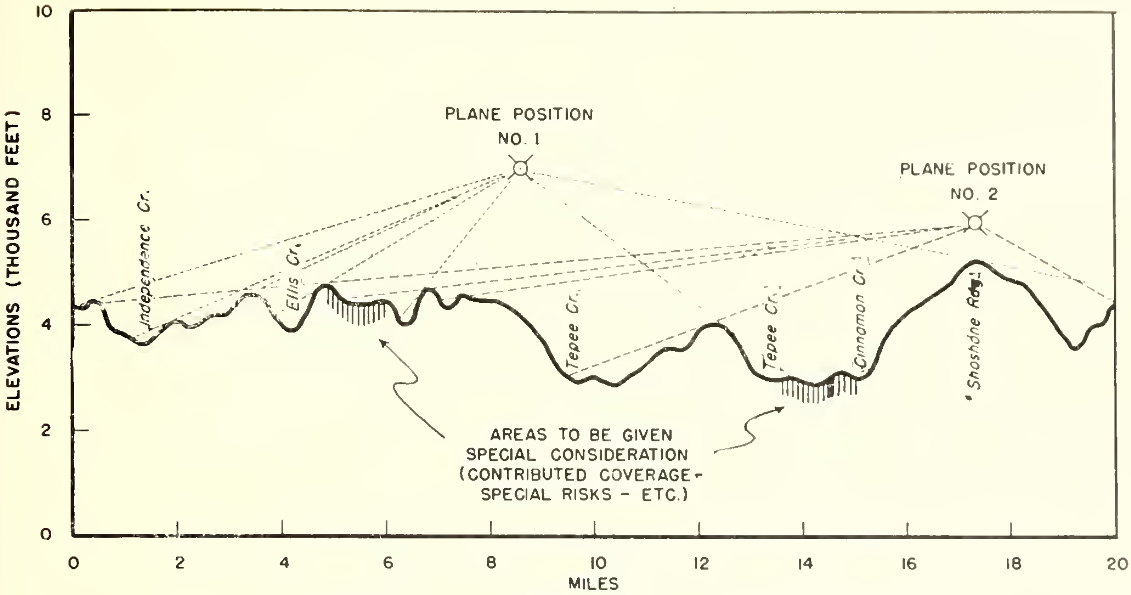
Cost Comparisons

As plotted on a cost basis, the air detection curve quite naturally starts at a higher level but increases at a lower ratio than the ground detection curve, and this is true up to a very high degree of coverage. With the ground organization, it has been determined that even under the most favorable conditions and where the justification is greatest, about 80 percent coverage is the limit that can be attained economically. Therefore, by plotting the two curves on a similar scale, it is possible to show graphically the theoretical point at which ground detection should be discontinued and air detection taken up to meet any particular situation.

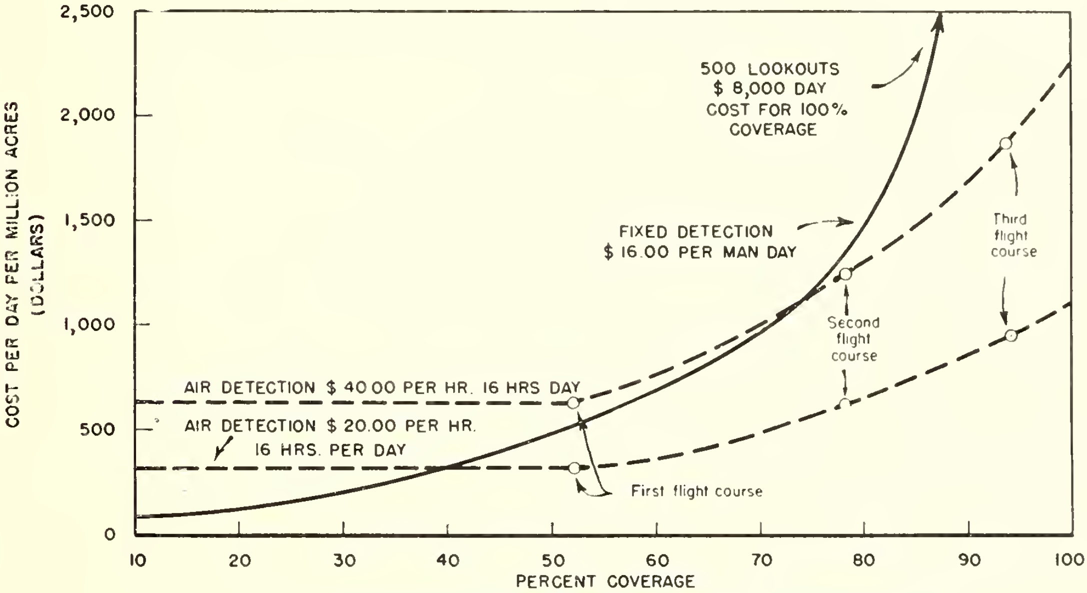
The detection data for ground coverage as worked out for the Coeur d'Alene Forest were used. For the past 7 years all forests in the region have had their fire control plans based upon an established rating for warranted degree of coverage, and that rating for the Coeur d'Alene is set at 79 percent. This means that the forest should have 79 percent of its area under direct visibility within an 8-mile radius when the danger class has reached 70, indicating the need for a full, normal-season organization. To obtain that degree of coverage in this instance requires the manning of 88 lookout stations per million acres, at a present-day cost of $16 per man-day for salaries and subsistence, and including prorated overhead.

We have no definitely fixed per-hour rate for air detection to correspond with the $16 per day ground detector rate. Forty dollars per hour is the present rate for our contract Travelairs, the planes we frequently use for patrol because they will also accommodate two fully equipped smoke jumpers. As nearly as we can determine, $20 per hour is a liberal rate at present prices for fully adequate types of ships for straight observation flights over mountainous terrain. Rates will vary greatly according to conditions and in an actual case it would be necessary to determine the rate specifically for the area under consideration.

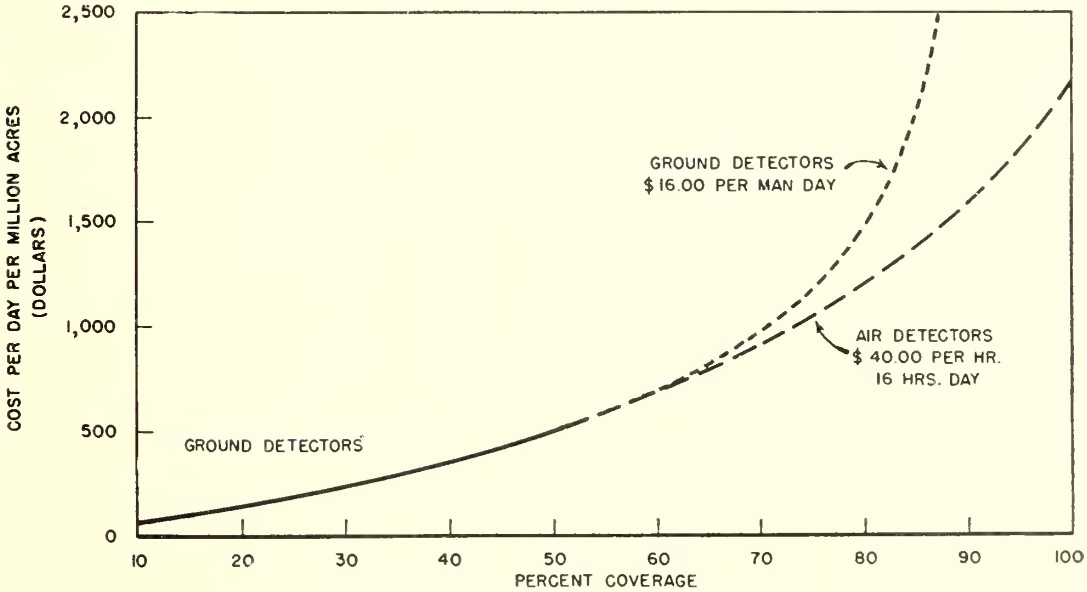
Now let us see what happens when we apply the corresponding air detection coverage on a cost basis (see B). It costs so much to put one plane in the air and to maintain the desired frequency standard that below 52 percent coverage there is no reduction in cost. One flight course, properly selected, will give 52 percent coverage. Subsequent courses add relatively less, as would be expected, although



A.- CROSS-SECTION PROFILE - AIR DETECTION



B.- COMPARISON OF AIR AND FIXED DETECTION
COEUR D'ALENE NATIONAL FOREST - REGION I



C.- COMBINATION-AIR AND FIXED DETECTION
COEUR D'ALENE NATIONAL FOREST - REGION I

the point of diminishing returns is met at a much higher percentage level than with ground detection, because of the flexibility of the air coverage. It was found that adding a second flight increased the coverage to approximately 78 percent, while a third flight brought it up to 93.5 percent.

Any interested person can determine a specific rate for his particular area and figure the comparative costs from the chart by interpolation. At $40 per hour for flying time (cost to include time and expense of observer as well as overhead elements) the air detection curve crosses the ground detection curve at 73 percent, which indicates that all coverage in excess of this figure can be obtained more cheaply by air patrol. At $20 per hour the corresponding figure is 39 percent.

These direct comparisons indicate what might be expected if air detection was substituted for the fixed lookout system. However, the most economical method would be a combination of the two, and the cost relationship can be determined by observing where the ground detection curve becomes steeper than the corresponding air detection curve (see C). Using the $40-per-hour figure, we find that fixed detectors should be placed in sufficient intensity to give about 55 percent coverage, which requires 37 positions per million acres. Further reference to the same chart indicates that the remaining coverage required to build up to 79 per cent can be obtained by air patrol at a saving of approximately $250 per day.

These comparisons are based upon a high frequency rate of observation (15 minutes per hour). Such rates would not always be necessary, particularly in areas of low occurrence and low hazard. Even in the more critical units, there is a chance for great savings over and above those shown by the direct comparisons. The cost of a ground lookout system in isolated areas goes on day after day, hour after hour, even during those times when the danger has been temporarily relieved and detectors are not needed. In the air detection plan only the few observers are a fixed charge. On safe days planes are grounded or used for other purposes, and on many other days of low danger the frequency of observation can be drastically reduced. Also, it is evident that greater flexibility will allow vulnerable spots and critical situations to be covered with far greater intensity with air patrol than with the conventional ground detector system.

Another and probably much greater source of savings should not be overlooked. Even a moderately intensive ground detection system involves a large investment in improvements, servicing facilities, and other elements not included in the foregoing analysis. In the Continental Area, for example, some 40-odd ground positions were eliminated, 32 of these being detectors. The cost of maintenance and replacement of living quarters, observatories, transportation and communication systems that were needed simply to service this organization amounts to considerable. To this should be added the operating and upkeep costs of pack stock, trucks, and warehouse space, together with the servicing personnel and the additional overhead required to recruit, train, and supervise a force of 40 men scattered over 2 million acres of roadless wilderness. Such considerations, while not included in the data, may be regarded as tending to balance some of the real or ostensible advantages of ground over air detection.

INSTRUCTION FOR PRESERVATION OF FIRE EQUIPMENT BY ARMY METHODS

Nels H. Orne, *Engineer*
Forest Products Laboratory, Madison, Wis.

During the war years the Matériel Containers Division of the Forest Products Laboratory conducted corrosion experiments in conjunction with the Army Service Forces in which the use of various corrosion preventatives were studied. This article, or set of instructions, was prepared at the Laboratory at the request of the Division of Fire Control, after the author had completed a detailed report entitled "A Study of Army Service Forces Methods of Preservation for Use With Fire Control Equipment." The use of these methods for various types of fire tools should greatly reduce the substantial losses resulting from deterioration. The Laboratory maintains lists of the suppliers of these preservatives and can furnish names upon request.

Army Service Forces methods of preservation were developed for many types of equipment and varied field and storage conditions. Preservation methods were based on the nature and function of the surfaces needing protection, as well as the types of exposure and degree of preservation desired.

Of the various preservatives available a number are considered suitable for fire control equipment. They may be readily applied with limited facilities.

The nature of the surface is one of the important considerations. Surfaces classified as noncritical, those which are not highly finished or operating surfaces, may be treated with a hard-drying, thin-film preservative. This category includes surfaces of hand tools such as shovels, axes, and brush hooks, as well as larger surfaces like those on fire line plows and other power equipment. For surfaces that are classified as critical, a soft, thick-film preservative is suitable. Critical surfaces include highly finished, operating, or machined surfaces, such as the external moving parts of pumps, plows, and power equipment, and cutting surfaces of saws, augers, and like equipment. Preservative lubricating oils are available for internal surfaces of engine assemblies and pumping equipment.

Cleaning Before Preservation

All equipment, in order to be effectively preserved, requires satisfactory precleaning. The degree of cleaning depends entirely on the character of the surface to be preserved. Noncritical surfaces can be cleaned for preservation with steel wool or a wire brush. Grinding is satisfactory, where adaptable. It is also advisable to soak or wipe the areas with a petroleum solvent or kerosene before applying the preservative. Critical or operating areas should always be wiped or soaked clean with a petroleum solvent before preservation. Crocus cloth is recommended for removal of corrosion in the cleaning process.

Preservation of Noncritical Surfaces

The hard, thin-film preservative recommended for preservation of noncritical surfaces dries to a coating the consistency of wax after application and the evaporation of the solvent in it. The preservative is available under Army Ordnance Tentative Specification AXS–673, Compound, Rust Preventive, Thin Film, and also under Army-Navy Aeronautical Specification AN–C–52, Compound, Exterior Surface, Corrosion Preventive, type 1. Although the preservatives available under the two specifications are basically the same, AXS–673 appears to offer the harder film. Equipment treated with the preservative can be used without its removal, although this should be governed by the use to which the equipment is put. The preservative is applied cold, either by dipping, brushing, or spraying. It is removed, where necessary, by soaking in kerosene. This removal can be accelerated if brushing or wiping is used in conjunction with the kerosene bath.

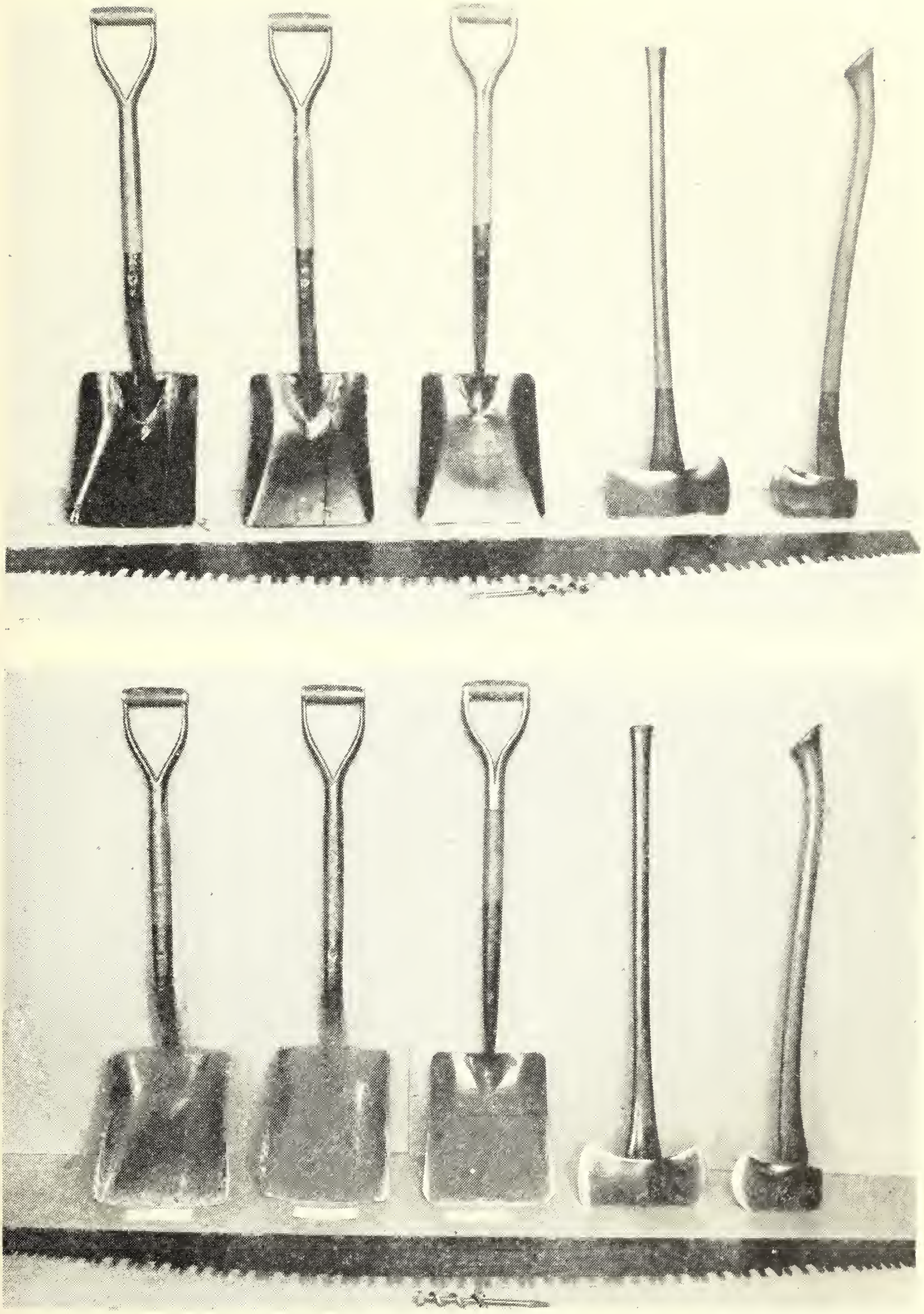
Preservation of Critical Surfaces

The soft, thick-film preservative recommended for use on critical surfaces is available under U. S. Army Specification 2–84, Compound, Rust Preventive, Light. It is a soft grease which may be applied cold by brushing at temperatures above 60° F. or by dipping in the preservative, where the size of the piece of equipment permits, with the preservative at 130° F. Surfaces coated with this preservative should be covered with a greaseproof wrap of any grade or type to facilitate handling. The soft consistency of the preservative permits the removal of a major portion of it by wiping without the use of a solvent, and complete removal by soaking in kerosene. Brushing and wiping while in the kerosene bath will accelerate the removal of this preservative, especially on parts hard to reach.

Preservation of Internal Surfaces

If an engine or motor is to be stored, the preservative most suitable for its internal surfaces is a lubricating oil containing a rust inhibitor. A preservative recommended for internal combustion engines is available under Army Ordnance Tentative Specification AXS–934, Oil, Engine, Preservative. The preservative is available in grade 1, equivalent in viscosity to SAE 10, and grade 2, equivalent to SAE 30.

Gasoline engines which have been operated on leaded gasoline must have their fuel tanks and crankcases drained and the engines then operated on unleaded, undyed gasoline for a 10-minute period, with the crankcase filled with grade 1 preservative. If the winter grade of oil, SAE 30, is specified because of special conditions, grade 2 preservative should be used in the crankcase. Where the engine has been operated on unleaded gasoline, the run period should be reduced to 5 minutes. Upon completion of the run period, seal the breather opening to the crankcase and drain the fuel and water-cooling systems. Seal openings after draining. Tape conforming to Joint Army-Navy Specification JAN–P–127, Tape, Adhesive, Pressure-Sensative, Water Resistant, type II, grade B, is recommended for sealing the openings.



Hand tools treated with preservative AXS-673: upper, before being put to a use-test; lower, after.

Attach a red tag to the oil filler cap; tag to read: "CAUTION—This engine has been treated for storage ———— (Date), and contains preservative engine oil. Drain and refill with seasonal engine oil before putting into service."

For protection of internal operating surfaces other than in engine assemblies, a preservative available under U. S. Army Specification 2–122, Oil, Lubricating, Preservative, Medium, is most suitable. This oil is an inhibited lubricating oil of vicosity SAE 30. It may be applied by dipping, brushing, spraying, or pouring into the interior surfaces. The preservative may also be used where an exterior surface coating is desired, although for satisfactory protection the piece of equipment should also be packaged in a waterproof package.

Army Range Finder Impractical for Fire Detection.—During the 1946 fire season Region 3 tested a standard U. S. Army Range Finder M–1916 for its usefulness in fire detection work at a tower in the Cibola National Forest, N. Mex. Because of its 1-meter square base and large mount the range finder could not be placed in the tower cabin. It was set up in the open at the base of the tower, thereby forcing the lookout to descend and ascend the tower for each observation. It was usually necessary to move the range finder to a different location for each smoke because of obstructions in the line of sight at the tower base.

The actual method of operation of the instrument is quite simple, and can be taught in a few hours to any individual of normal intelligence and normal vision. Unlike a transit or level, however, an abnormal amount of assiduous daily practice for several weeks or more is required before satisfactory competence can be attained. This is due to the manner in which the observation is taken. An accurate observation demands that an inverted image and an erect image of the target be brought just to, or only very slightly equidistant from, a horizontal line, and simultaneously in line vertically. Inexperienced observers may be surprised to find two successive observations on the same target give a difference in range of as much as 2,000 yards. Even experienced observers seldom obtain the same range on successive observations. In battle use, observers usually take five observations, select the two closest together, and use the mean range between these two.

The range scale on the finder reads from 400 to 20,000 yards, or roughly ¼ to 11 miles. The lower limit is no handicap. The upper limit, however, is somewhat less than the normal visibility in Region 3. Also, slight adjustments in alinement of images can change the range of a distant fire 1,000 yards.

The type of target usually encountered in fire detection adds to the possibilities of error. Battle observers try to pick sharp, well-defined objects such as buildings. The lookout, however, normally has a poorly defined target: a smoke column where it meets the ground or horizon. Such a target is almost impossible to bring into proper alinement.

From the experience in Region 3 with the Army Range Finder M–1916, these conclusions are drawn:

1. The amount of training and practice needed to insure a satisfactory standard of competence limits the use of this instrument to cases where observers will be more or less permanent.
2. Reasonably accurate observations of range were made on a maximum of 50 percent of fires within 5 miles of the lookout, and a maximum of 10 percent beyond 5 miles.
3. The size, shape, and character of the instrument itself makes its use very inconvenient at the average lookout.
4. The inspection, performance testing, maintenance, and repair needed to keep the instrument up to a satisfactory standard will add appreciably to someone's work load and will be expensive because it would require specially trained men.

W. Ellis Wiltbank, *Cibola National Forest, Region 3.*

WE PRODUCE FIRE TRAINING FILMS

J. Whitney Floyd
Chief Forester-Fire Warden, State of Utah and Professor of Forestry, Utah State Agricultural College

We needed fire training films. Together *We* are producing them.

During those man-shy fire years of 1942 and 1943 we, the fire control agencies in Utah, found ourselves faced with a huge fire control program but short-handed for men. The short-term men were too inexperienced and inadequately trained to cope properly with the fire training and suppression responsibilities at hand.

Something had to be done and a promising source of help was the Forest Fire Fighters Service being sponsored by the National Office of Civilian Defense. This we organized on a State-wide basis. We proceeded to recruit and train volunteer fire fighters to replace our former forces of Civilian Conservation Corps crews and regular personnel, who were largely in military service.

Our first State-wide training program was undertaken in the spring of 1943 with a three-man training crew made up of a representative from each of the following agencies: United States Grazing Service, United States Forest Service, and the Utah State Board of Forestry Fire Control. This team assisted every county Forest and Range Fire Fighters Coordinator in the State to train the volunteer fire fighters. One training deficiency was very noticeable. Aware of the most up-to-date Army training methods, trainees and trainers alike, repeatedly expressed their desire for visual aids to be used for training in brush-grass fire fighting techniques.

At the conclusion of the spring training program the training team expressed to the State Forest Fire Fighters Service Committee a general interest in producing a fire training film that could be locally adapted and applied. On August 20 of 1943, the State Coordinator called a meeting of his committee to consider the possibility of the fire control and land administering agencies cooperatively producing a fire training film. Subsequently, a questionnaire was sent out to the field personnel of the Forest Service, Grazing Service, Park Service, Extension Service, Soil Conservation Service, and Indian Service, and to State Forestry employees, asking for suggestions and opinions regarding what type of film they thought should be most suitable.

Ninety field men from the States of Idaho, Nevada, Wyoming, California, and Montana, expressed themselves in writing as to the needs and the quality of a brush-grass fire film. On December 10, the State Coordinator of Utah called a meeting of representatives from Idaho, Nevada, and Utah, to discuss plans for financing and organizing for the joint production of a brush-fire training film. The following points were discussed and agreed upon:

1. There is definite need for a fire training film covering fire suppression in cheatgrass and grass-brush types, and limited to the local area of Utah, Nevada, and Southern Idaho where cheatgrass is a big problem.

2. It should be 16 mm., in color, with sound, and be voiced by a narrator.
3. It should be simple, direct, and start right into action on suppression training with very little prevention or introductory material.
4. It should be directed to cooperators, per diem guards, and small volunteer crews—all with very little or no training.
5. It should not be over 30 minutes long—shorter if possible.
6. It should be limited to a small problem, a 5- to 7-man job, and should deal with the action expected to be taken on a small fire, using common hand tools—shovel and Pulaski tool.
7. In the development of the small problem the following points are desired:
    a. A small fire, 3 to 5 acres.
    b. As representative as possible of our intermountain foothill country.
    c. Use of relief models or sand table terrain on which fuels and burning conditions can be pictured in total so that the entire problem can be seen and visualized by the trainees.
8. The presentation of the problem should develop the chronological steps of handling a suppression job, with emphasis on the various parts:
    a. Preparatory arrangement and going to the fire.
    b. Sizing up the situation.
    c. Stopping spread.
    d. Completing control line.
    e. Mopping up.
    f. Staying with fire or checking later.
9. Financial arrangements among the cooperating agencies should be informal to avoid complex and cumbersome agreements.
10. To appoint a production manager with full authority to arrange for the scenario, to select the areas for filming, and to requisition contributed help and facilities from the cooperating agencies.

A committee of three men—a chairman with authority to represent Idaho, Nevada, and Utah on both State interests and State Forest Fire Fighters Service; a representative of the United States Forest Service; and a representative of the United States Grazing Service—was appointed to act as an executive committee to determine policy and make major decisions. With this organization and informal financial agreements, we approached the problem in the winter of 1943. A scenario was prepared by the over-all committee, and field shots and indoor shots were taken. The committee as well as the field crews used in staging the scenes were employees of the various agencies. Each man became so absorbed in his job of producing a training film that the entire project progressed as a purposeful task without agency affiliation. The finished film, “Grass and Brush Fire Fighting,” was released in March 1945. It has been credited by many of our control agencies as being one of the best of its kind produced to date. The cost of the film, including the contributed time of employees, travel expense, and cash outlay of all agencies, amounted to $7,307.42.

Our success in film No. 1 encouraged us to undertake a similar but more difficult project. On November 29, 1945, this same committee renewed its efforts to produce another film, “Fighting Large Brush and Grass Fires.” The objective of this film, with emphasis on organization and communication in fire fighting, is to demonstrate the fire control techniques used in fighting large brush-grass fires with heavy equipment. Inside filming on an actual scale relief model was completed in the early spring of 1946 and the field shots were taken during the summer. Cutting and splicing the film, and adding the narration, are being done now. It is hoped that this film will be as useful for training fire fighters as was the first one.

Film No. 1, "Grass and Brush Fire Fighting," was finished by the Calvin Co., 1105 East Fifteenth Street, Kansas City, Mo., and may be purchased for $110. The State Foresters of Idaho, Nevada, and Utah; the U. S. Forest Service; and the U. S. Grazing Service have copies in their libraries for local use.

The New Ration E.—On September 18 about a dozen men sampled the new Army Emergency Ration, type E, at a luncheon arranged by the Equipment and Supply Section of the Division of Operation in the Washington Office of the Forest Service. Among those present were Messrs. Loveridge, McArdle, Campbell, Kramer, Godwin, Brown, Holden, and Kaylor. The group appeared to enjoy thoroughly the "ration luncheon," and the new ration was found generally acceptable to all.

The War Department advises that ration types K and C will be replaced by type E in the very near future. The Forest Service procured from them one case of the new type E for experimental purposes. Each case contains 48 cans, 8 accessory packets, and 8 cigarette packets. It is known as an 8-man ration case, and is designed to subsist 8 men for 1 day, or 1 man for 8 days. Each ration includes 1 accessory packet, 1 cigarette packet, and 6 cans (2 meat, 1 fruit, 2 B-units, 1 bread).

The 48 cans and 16 packets in the case procured were as follows:

8 B–1 units (a breakfast unit with cocoa and 1 unit of coffee, sugar, crackers, jam, and cereal).
8 B–2 units (a supper unit with 2 units of coffee and 1 of orangeade, candy, crackers, cookies, jam, and sugar).
8 bread (white).
8 fruit (cocktail).
4 hamburgers and gravy.
4 pork and beans.
4 pork and rice.
4 meat and beans.
8 accessory packets (gum, granulated salt, heat tablets, salt tablets, toilet paper, and can opener).
8 cigarette packets (9 cigarettes and 1 match book).

The meat and fruit units will vary according to the particular case received, since there are available 10 different kinds of meat items and 4 fruit items. Other meat units are chicken and vegetables, beef stew, frankfurters and beans, ham and lima beans, meat and noodles, and meat and spaghetti. Peaches, pineapples, and apricots are the remaining fruit units.

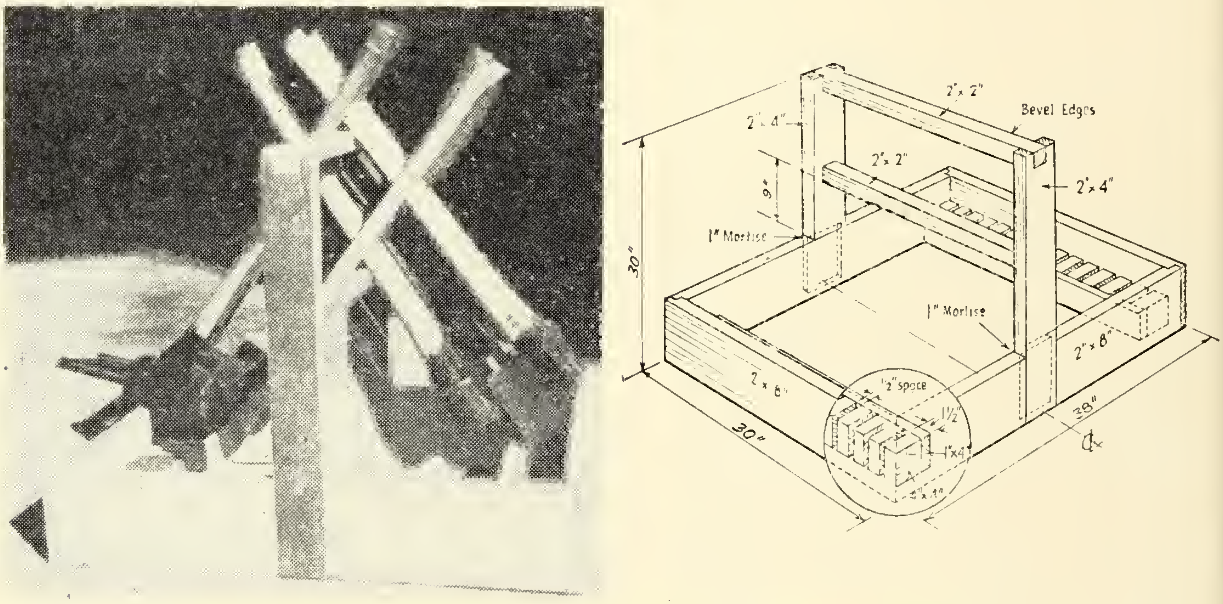
The E assembly permits considerable choice and more variety than the C or K rations. Also, it has more bulk and better palatability than the K. However, it is not so neatly separable into one- or two-man meal units as the K, which was popular because of its compact packaging.

One case of E rations has been sent to each Forest Service Region for sampling and comments.—John B. Holden, *Equipment and Supply Section, Washington Office, Forest Service.*

BRUSH HOOK RACK

L. A. Horton
District Ranger, San Bernardino National Forest, U. S. Forest Service

Convenience, safety, and a large storage capacity are the merits of a brush hook rack developed on the Mill Creek Ranger District. The rack is designed to hold 50 brush hooks placed in alternating positions, i. e., 13 blades down and 12 blades up on each side. This arrangement allows the backs of the 13 hooks to act as safety guards for the other 12. The blades of the hooks on each end of each row should always be placed down for safety. The tool handles are interlocked on the top and bottom cross bars. Two heavy chest handles on each side of the rack facilitate moving the rack or loading the unit on a truck without removing the hooks.



Rack with brush hooks in position, and diagram showing details of construction.

Tractor Transportation on Fires.—Forest officers have from time to time discussed the use of tractors in transporting supplies to isolated fire camps. Usually discussion centers around the use of stone boats or some arrangement of wheeled trailers. On the East Creek Fire on the Mineral District in 1945, a 55 tractor supplied the Eagle Creek Camp throughout the period it was occupied. The maximum number of men in the camp was 35, but the tractor could have supplied many more.

No stone boats or wheeled trailers were used. Division Boss Payne, faced with the necessity of moving a 35-man camp into isolated Eagle Creek, used alder poles, No. 9 telephone wire, spikes, two-by-fours, but mostly ingenuity to arrange a carrier on the principle of the Indian travois. Alder poles were inserted under the bulldozer hoist arms and wired to the frame work. These poles extended about 6 feet to the rear of the tractor on either side. Two-by-fours were spiked from pole to pole.

On this platform the camp equipment, mess gear, stoves, and bedrolls were piled. The load was covered with a canvas and securely lashed down. "She was big and cumbersome," said Payne, "but she got there. She was complete with tarp and all. We could have even thrown a diamond hitch, except I have forgotten how it's done."

On this particular job the country was so steep the tractor could not have made the return trip with either a stone boat or trailer. The travois arrangement performed satisfactorily on all the trips throughout the entire fire. The round trip distance was approximately 4 miles.—A. B. Everts, *Forester Snoqualmie National Forest, U. S. Forest Service.*

FEW FOREST FIRES IN GERMANY

EDWARD RITTER
Eastern Region, Forest Service

Go east, young man, if you are looking for a forest fire fighter's paradise. Incendiary bombs, phosphorous leaflets, tracer bullets, flame throwers, plane crashes—and yes, even cigarettes failed to start serious forest fires in western Germany during the war. From the small woodlots north of Cologne to the Black Forest of Baden, there was little evidence of forest fires. True enough, there were small burned areas in the Phalzerwald between Kaiserlautern and Ludwigshaven where a convoy of the Fuehrer's retreating supermen were strafed and their various vehicles and war machines went up in flames. In the Hurtgen Forest artillery air bursts damaged many trees. Considerable cutting by troops and forestry companies left much fuel on the ground. But the fall and winter of 1944–45 were cold and wet with much rainfall and snow. Even during the dry month of April 1945, however, there were no fires of consequence west of the Rhine.

After VE-day, in June 1945, about the time the British took over military occupation of the Rhine Province, a relatively large fire, nearly 600 acres, occurred in the eastern edge of the Hurtgen Forest. This was perhaps the largest single forest fire west of the Rhine during the last few years.

There was very little fire weather in northwestern Germany between July 1945 and June 1946. In Greater Hesse evidence of at least 100 fires was noted during the spring season of 1946. *Cause:* Probably hunter and warming fires, cigarettes, and incendiary. *Size:* From a few square feet to 10 acres. *Fuel type:* Spruce plantations 3 to 20 years of age with heavy crop of dry grass scattered throughout. *Damage:* Seedlings and young trees burned or badly scorched with mortality from 25 to 100 percent. *Percent forest area burned:* Estimated 0.025. *Risk:* Thousands of city people were in the forests continuously, chopping, carrying, and hauling fuelwood. Thousands of American soldiers were hunting, fishing, and wandering through the woods. Seventy-one thousand displaced persons from 20 different nations were in the process of repatriation during one 6-month period and the influx of another 57,000 added to the risk of the 4,000,000 German civilians who inhabited the area.

If forest fires were the most critical of the problems in Germany, we might be assured of a lasting peace as well as a forest fire fighter's paradise.

ARMY EXPLOSIVES FOR HAZARD REDUCTION

G. B. Johnson

Regional Fire Dispatcher, North Pacific Region, U. S. Forest Service

Many of the items developed by and for the Armed Forces during the recent war years are adaptable to forest fire control activities and the Forest Service has conducted tests to determine their practicability for this purpose. During the past year, in cooperation with the Army Corps of Engineers, tests were made with demolition explosives in felling snags.

Explosives furnished by the Corps of Engineers consisted of Tetrytol Demolition Chain M–1, Composition C–2, Composition C–3, Shaped Charge M2A2, and Shaped Charge M2A3. Three Army technicians, a commissioned officer and two noncommissioned officers, were assigned to the project.

Description of the Explosives

Tetrytol Demolition Chain M–1 consists of eight blocks of Tetrytol spaced 8 inches apart on a detonating cord (primacord) through the center of the blocks, with 2 feet of primacord on each end of the chain. Blocks measure 2 by 2 by 11 inches and weigh 2½ pounds each. Consistency of the explosive is hard and brittle. The velocity of detonation is 23,000 feet per second. Relative effectiveness as an external charge is 20 percent greater than TNT. Detonation may be obtained with a standard electric blasting cap attached to the primacord.

Composition C–2 is a plastic explosive of a consistency similar to putty and may be easily molded to obtain close contact for demolishing irregular shaped objects. Plasticity remains practically the same at temperatures ranging from 20° to 125° F. The explosive is packaged in blocks 2 by 2 by 11 inches, weighing 2¼ pounds, each block wrapped in glazed paper and enclosed in a cardboard carton. Eight blocks are packed in a cloth haversack with shoulder strap. A wooden powder box contains two haversacks. The velocity of detonation is 26,000 feet per second. Relative effectiveness as an external charge is 34 percent greater than TNT. Commercial explosives in the straight nitroglycerin and ammonia types of 60 percent strength have a relative effectiveness as external charges 83 percent and 53 percent, respectively, of TNT. A special Corps of Engineers' electric blasting cap or primacord is required for detonating C–2. This special cap is considerably stronger than a standard No. 8 cap.

Composition C–3 is similar in all respects to C–2 except that it is lighter in color and somewhat more plastic.

Shaped charges M2A2 and M2A3, designated as 10-pound and 15-pound charges, respectively, are identical except for the amount of explosives they contain. They are also referred to as directional charges. The unit consists of a fiber container so shaped that a considerable part of the explosive energy is concentrated in one direction, resulting in an action known as the "Monroe effect." The explosive container is cylindrical with a cone-shaped top and a conical recess in the bottom. The explosive charge is loaded in the container at the factory. There is a detonator well in the top of the cone in which the detonator is inserted and secured by means of a plastic adapter. In the blasting operation the charge is placed on a fiber cylinder support, approximately 6 inches high, which keeps the charge at exactly the proper distance from the material to be penetrated. The action of these charges produces a penetrating effect rather than shattering. Several charges were tried on basalt rock with the following maximum results: One 10-pound charge penetrated 18 inches, and a second 10-pound charge placed over this hole deepened it to 32 inches; a 15-pound charge penetrated 28 inches, and another 15-pound charge placed over the hole deepened it to 44 inches. The diameter of both holes was 2½ inches. A special Corps of Engineers' electric blasting cap is required for detonation.

All of these explosives are highly inflammable. Tetrytol will burn at the same temperature as that required to ignite TNT. Fires are readily set when light fuels are dry and this is especially true when charges are not confined with stemming or mudcapping. They are exceptionally safe to handle because of their very low sensitivity as compared to commercial explosives and this accounts for the necessity of using a strong detonating agent.

Tests in Felling Snags

The tests were conducted in the old Yacolt burn on the Columbia National Forest. This area is the result of a disastrous fire which occurred in 1902, and while the fire-killed snags have been standing for 44 years, many of them are sound at the base. It was intended to make the tests on sound snags only but a few snags with varying degrees of decay were inadvertently shot. The latter are eliminated in determination of results obtained. All snags were Douglas-fir and ranged from 25 inches to 76 inches d. b. h.

Four methods of loading explosives were employed: (a) Sawed and chopped notches, unconfined and confined with mud, (b) auger bore holes, (c) external ring of Tetrytol Demolition Chain, and (d) Shaped Charge holes. Two notches, one each on opposite sides, and single notches were tried. Two cuts, with a saw, 4 inches apart and 5 to 8 inches deep are required for each notch. Wood was removed with a Pulaski tool. In boring holes for loading internal charges a portable electric power auger was used. This method is described in the Fire Control Equipment Handbook.

Results

Results obtained were as follows:

(a) After several trial shots it was determined that the amount of explosives in pounds required to fell a sound snag, using notches to contain the charge and without mudcapping, was the diameter squared and divided by 100. Thus, 25 pounds of C–2 or C–3 were required for a 50-inch d. b. h. snag. Where mudcapping was used the charge could be reduced 20 percent. There was no advantage in using two notches with or without mudcapping. A clean shear was not obtained with this method. Frequently slivers up to 8 feet were left on the stump. Direction of fall could not be controlled.

(b) It was found that C–2 or C–3 was no more effective than a commercial 40 percent ammonia dynamite. A disadvantage was the time consumed in loading the 1⅛-inch bore holes. It was necessary to mold small pellets or rolls from the block of C–2 or C–3 to permit loading the hole.

(c) Tetrytol Demolition Chain wrapped around the exterior of a snag was successful up to 36 inches d. b. h. and a clean shear was obtained. This is a very fast method of felling a snag of this size and smaller. However, the amount of explosives used is considerably greater than required in the notching method, and it is exceptionally bad for setting fires.

(d) Shaped charges were tested to determine depth of penetration horizontally and for a means of quickly putting in a hole for loading and felling a snag with an internal charge. Several experimental shots were tried and finally a 15-pound charge was placed on the side of a 76-inch d. b. h. snag. The result was a hole entirely through the snag, 4 inches in diameter at the charge end and 1½ inches on the opposite side. The hole was loaded with a charge of C–3 computed to be sufficient to fell it. This failed, and it was subsequently felled with an overload of C–3.

Ten-pound and fifteen-pound charges were used to shoot holes through snags of varying diameters, which were left for a later test of final felling by the burning method. Results were not available at the time this article was written.

Paradoctor Appointed in Region 1.—Region 1 has completed arrangements for the service of Dr. Amos R. Little, former Army paradoctor, on emergency cases in inaccessible parts of the northern Rockies. The appointment of Dr. Little on a "when actually employed" basis marks an important forward step toward adequate protection against death from lack of immediate medical care in back-country accidents or other medical emergencies. The idea of parachuting civilian doctors originated with the late Dr. Leo P. Martin, of Missoula, Mont., who trained with the Forest Service smoke jumpers in 1941 and was killed in the crash of an Army plane a year later.

Dr. Little's preparation for this special work has been particularly applicable. He was sent to Missoula in the fall of 1943 as one of a party of 13 Army medical and training officers assigned for the purpose of training in Forest Service methods of parachute jumping. After training, Captain Little was assigned to search and rescue operations out of Casper, Wyo., and made several rescue jumps from that base. One highly successful rescue performed at 11,000 feet in the Colorado Rockies won him a medal as well as considerable repute as a skilled paradoctor.

During the summer of 1945 he was transferred to Great Falls, Mont., and his skill as a jumper was used successfully on several back-country accidents. Captain Little's services in these cases were in addition to his military search and rescue duties.

A graduate of Johns Hopkins Medical School, Dr. Little is now a practicing physician at Helena, Mont. The form of appointment and the nature of his duties in no way overlap or conflict with existing medical facilities available to the Forest Service, but add to its efforts to provide the maximum in medical service for its widely scattered field employees.

○

olume 8 Numbers 2 and 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

NITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1947

Contents

Pag

Fire control in resource management
A. A. Brown

Fire control logistics
Frank J. Jefferson

Mobile 25-man outfit
John B. Fortin

A dual purpose hazard reduction burner and foam unit 1
A. B. Everts

Caught—three firebugs 1
Bill Huber

Killing brush with 2,4–D 1
Robert K. Blanchard

Region 6 Equipment Development Laboratory 1
Theodore P. Flynn

Tower door counterweight 2
Favre L. Eaton

A forest fire truck 2
William H. Smith

Alaska helicopter "first" 2
Roger R. Robinson

Virginia's use of airplanes for fire control 2
Hunter H. Garth

A rural fire fighting tanker 2
August P. Beilmann

Effectiveness of aerial detection 2
Division of Fire Control, U. S. Forest Service

Forest fires and sea breezes 3
G. L. Hayes

Revision of fire equipment handbook and master specification file 3
Division of Fire Control, U. S. Forest Service

The Aamodt stubby plow 3
E. E. Aamodt

Chelan humidity finder 3
Simeon A. Beeson

An improved broom-rake for line construction 3
Paul F. Graves

Light tractor-tanker vs. ¾-ton weapons carrier tanker 3
J. W. West and J. W. Mattsson

Parachuting heavy odd-shaped objects 4
James V. Waite

Shasta coffin tanks and trailer 4
M. O. Adams

FIRE CONTROL IN RESOURCE MANAGEMENT

A. A. Brown

Assistant Chief, Division of Fire Control, U. S. Forest Service

Some observers at the recent Forest Congress were impressed by the undue degree to which we have separated protection of our forest resources from fire, insects, and diseases from the other management phases of the job. Others have felt that there is a conflict in some of our present conceptions. This question is highly important to the proper balance of effort in our Land Management job as well as to the continued sound progress of the protection phases of the job. Some stock taking seems in order.

The methods, policies, and traditions of modern forest-fire control began in the West. They strongly reflect the influence of huge areas of back country and of unmanaged, abused or extensively managed forest areas. The fire problem in such country is big. Men are often pitted against great forces of nature and are challenged to increase their stature figuratively to contend with them. So the conflagration fire involving many thousands of acres and the periodic threat of complete disaster tend to dominate thinking and planning.

The bigness and the challenge of such problems have contributed much to the quality and resourcefulness of Forest Service personnel from the start. In popular fancy, and even among the ranks of foresters, this kind of fire control has impressed itself as the whole of the job. It has been an easy step from this conception to the belief that forest fire control when fully perfected can consist everywhere of a specialized protection service to be provided by technicians, like a fire chief and his crew in a big city. With that done the householder can go happily about his other affairs and simply buzz twice if he needs a fireman.

A good many silviculturists and other resource specialists and even some administrators now take this view, and see no reason to concern themselves with fire control. Perhaps the highly developed technical phases of the fire control job and the specialized equipment which have rapidly evolved have contributed to this viewpoint. Such things encourage the comforting belief that it is a specialist's job and the responsibility could very well be disposed of by "contracting" for the job on a routine basis. This kind of thinking ignores the intimate relationship both between fire and the existing forest and between fire and the job to be accomplished.

Fire, for the most part, was the eventual harvester of the timber crop in the virgin forest. Allied with storm, flood, insects, or disease, it removed the old and started the new. Such old relationships are faithfully reflected by the characteristics and prevalence of many of our most valuable species. When man became the harvester, these old relationships were disturbed. The immediate effect was to greatly increase the occurrence and effect of fire. The combined effect of fire and man's harvesting activities produced consequences which made the control of fire essential to stability.

Most present day forest units have a fire history reflecting these disturbed relationships. Over whole regions, fire in the recent past has determined the condition and present value of the forest resource. It has been decisive too in determining the productivity of forest sites and in the selection of species that now prevail. In turn, fire history has limited and continues to affect the whole social and economic pattern of the region concerned.

As fire-control measures become more efficient the significance of fire to the forest seems less important. But success only in reducing the areas burned each year does not relegate such things to the past. Fire has such varied effects under different conditions that simple exclusion may not be enough to enable skillful silvicultural or other management. There is increasing evidence that advanced practice is likely to call for some use of fire as a tool of management in order to then reestablish some of nature's old relationships. The forest manager must understand these relationships to his forest before he can manage it successfully.

Several principles are involved in relation to his over-all job.

In extensive management of wild land, fire has to be controlled. Alone, that is a sufficient basis for building extensive systems of fire control and for judging results only in terms of percent of protected area disturbed by fire in any given period. No fine distinctions are needed in an aggressive policy of controlling fires that start. The necessity of preventing man-made fires has also been generally accepted. On such premises our forest fire control policy and progress have been built. It has been patterned to the problem of holding down heavy fire losses on extensively managed or badly managed areas of wild land. In such areas, existing fire risks and fire hazards had to be accepted as a part of the fixed problem and the organization and methods had to be designed to fit.

Now that intensive management of a rapidly increasing portion of timber, range, wildlife, and watershed lands is becoming a fact, some changes in the manager's relationship need to be recognized. On really intensively managed areas, the magnitude of the fire job is no longer fixed. Methods within the manager's control can eliminate the old threat of complete disaster and can even cut down the size of the job so that his management organization can handle it. This process is never concerned solely with fire. It is less spectacular but more realistic than the alternative of building an independent fire organization capable of meeting the worst that nature and management together can produce.

Forest fuels are the most important factor in this relationship. The amount of fuel that is allowed to accumulate and its continuity are recognized by fire control men everywhere as fundamental in determining the cost of effective fire control and in fixing the losses that are bound to occur over a period of years. Lack of utilization of wood on the ground has always created the worst fire liability. Anyone who recalls the great mass of fire-killed debris in the Northwest following the 1910 burns or who has seen the Tillamook burn does not have to be reminded that great areas of such debris set the stage for conflagration fires. Good management of timberlands will not allow such hazards to persist.

Similarly, traditional methods of clear cutting of Douglas fir in the Northwest create unmanageable fire hazards so long as great masses of wood representing vast storehouses of heat energy ready for the fuse are permitted. Wasteful clear-cutting of mature hardwoods and the great volume of dry fuel left behind have in the past created abnormal fire hazards in the Northeastern and Lake States. Similarly great open clear-cut areas fully exposed to sun and wind, even where natural forest fuels are light, create unnatural or unnecessary special hazards.

Some recent thinking has confused these relationships. The term "custodial" has been applied to the extensive type of management in which activities are restricted to protecting the area and building improvements. Such management was set off as the opposite to the ideal of a fully managed forest area. In promoting progress toward such an ideal, there has been a tendency to discredit the former as a part of the pioneering state which has now passed. In that process forest fire control became identified as part of the custodial job and even labeled as "custodial" in nature.

It is unfortunate that fire cannot be neatly catalogued as a "forest resource" in the effort to get foresters to give more thought to on-the-ground management, but protection enters so strongly into every phase and responsibility of that management that it has long been accepted as the first step.

Fire liabilities and probable losses depend in part on management practices on the ground and human risks and incendiary motives are apt to reflect administrative policies. The responsibility for successful results cannot for such reasons be closely confined to a small specialist group. Every forester of necessity must be something of a fireman. Undue emphasis on the operation or engineering phases of fire activities reduce this feeling of responsibility and in the long run tend to narrow the field of activity and opportunity of the forester.

Certainly "resource management" independent of any responsibility for active protection is hardly worthy of the name. If a distinction between degrees of extensive and intensive operation and management does need to be made it needs also to be applied to the practice of forest fire control. There is a pressing need to fully develop what may be termed "intensive management fire control." The status of the area manager is directly concerned. He cannot very well pass this responsibility to someone else if he aspires to be the real manager of resources on his unit.

The measures identified with intensive timber management which can reduce the fire potential that must otherwise be accepted in extensively managed areas, consist of good accessibility, small management units, close utilization, selective cutting where practicable, control of insect and disease epidemics, and some use of controlled fire. Comparable measures in raising the level of management of some other forest resources can also exert a profound effect. Increased employment of forest workers is also a characteristic of intensive management. Most of the employees, who under old methods had to be recruited and employed for fire control duties only, then become available within the area. In such ways the size of the fire job itself and the means of dealing with it then come progressively within direct control of the manager. To the degree this occurs, the chances taken and the losses that result become his direct responsibility. Insect and disease losses have a similar relationship.

In exercising "intensive management fire control" or "intensive management protection," skillful use of fire becomes an appropriate tool of management subject also to close control and adaptable to many purposes. The use of fire to reduce the amount of hazardous fuel following timber cutting is an early tradition of the Forest Service. Methods and costs in excess of the risk involved properly brought the practice of piling and burning slash into disrepute under many conditions. Under intensive management no fixed formula will serve. Intensive utilization and selective cutting will drastically reduce the need of such measures. But where they are needed, cost limitations become less exacting.

But use of fire only to reduce fire hazards is self-limited. No extensive burning of a forest area for the sole purpose of hazard reduction can be justified under intensive management. Such large scale operations must have positive value in promotiing other purposes of resource management as well. The degree to which "prescribed" burning can or should be utilized for seedbed preparation, control of diseases, control of tree species, etc., is as yet only partially explored in most forest regions. It represents a field requiring the best talents and joint effort of both the silviculturist and the fire control specialist. The term implies intensive management.

For an indefinite period ahead the powerful challenge of the big fire and of the heroic measures it calls for, will continue to characterize the more extensively managed forest areas. All successful measures so far developed and many more will need to be pressed into service to meet it successfully. It justifies much specialization. But the rapid expansion of intensive management brings new and more intimate relationships between fire control and the rest of the management job. Both fire control men and resource managers will do well to recognize these new relationships and to join forces in advancing "intensive management protection."

FIRE CONTROL LOGISTICS

Frank J. Jefferson

Assistant Regional Forester, Region 5, U. S. Forest Service

In military circles logistics is defined as that branch of the military rt which embraces the details of the transport, quartering, equipping, nd supply of troops in military operations. This holds true whether he undertaking be on land, air, or sea.

Fire control logistics requires the same undertakings but may be nore simply defined as the art of delivering manpower and matériel lready planned for in the right quantities in the right places at the ight time. Failure in any one of these elements simply means that all he high-powered knowledge of strategy, of fire behavior, etc., that nay be brought to bear upon a fire suppression problem by the highest anking brass hat in any Fire Control Service will come to naught nless someone somehow accomplishes all the essentials to consummate is plan. The fire boss calculates that with thus of men, this of tracors, and that of tankers he can control the fire on this ridge. But it is ot going to end a fire at a planned time unless that part of the organiation responsible for accomplishment of logistics puts the essential lements for control at the spot designated at the time and in the uantity prescribed by the fire boss. The fire boss, however talented, at the mercy of the practical application of logistics to the problem ith which he is faced. It is the quality of applied service of supply r logistics that determines whether we get a fire in its early stages, ave an extra period fire, or have one of those monstrosities that angs on for days until finally strangled by the weather or its own yrations.

In military circles the art of logistics ranks high in the training f every officer; months are spent on indoctrination in its intricacies. fficers are drilled, drilled, and redrilled in what constitutes the numrical human components of a squad, company, regiment or corps nd what the essentials to the movement, equipping, and operational ustenance of each unit are. Minute details such as the number of atches and compasses that are essential per unit are calculated. ap requirements are similarly closely calculated. It is important hat every officer responsible for logistical action understands comletely how many trucks are required and how many men are needed load and unload them for a given movement within a given time or each unit of command, and what the command requires in the ay of field equipment, mess equipment, rifles, revolvers, and other mplements of war. He must also understand what the attritions f war action calculably are, and that he make provision for current eplacement to offset this attrition. The problems in this field are aterially different between ground, sea, and air forces; in fact, so ifferent in some respects as to be almost opposites.

We in the Forest Service must deal with all three; primarily, ground requirements; secondarily, air—which in some quarters is crowding close to the ground requirements in volume; and, thirdly, sea, as exemplified by the Lake States situation, actions on Lake Chelan Coeur d'Alene, Pend Oreille, and Mount Shasta. We have not yet however, sufficiently comprehended the sharp differentiations that exist in the logistical technics applicable to the three methods of transport. In the cataloguing of matériel and manpower required for an attack under each of the three methods of approach we have progressed. In training of men in the technics of logistics we have done practically nothing. We still largely depend upon pinch hitters for chiefs of staff and, practically, pretty much still follow the tradition of early days when somebody said, "Hey, Bill, there's a fire on Sauerkraut Ridge," and Bill proceeded to round up all available men, shovels, axes, and hoedags and headed them toward the fire. This is admittedly somewhat of an exaggeration because we have developed to a point where we recognize the No. 0 ladies' shovel as a more effective fire-fighting tool than a No. 2 shovel and far more effective than a square-pointed D-handled scoop shovel. But more important (and granting that fires can be put out with scoop shovels) we have not yet made a dent in the art of getting the right things in the right quantities in the right places at the right time.

The fire boss contemplates use of an RD-7 angledozer or power-operated plow. Due partly to lack of equipment, more often due to lack of ingenuity in the art of substitution, the desired machine power arrives hours too late to fit his plan. Manpower desired by the fire boss at a given time arrives hours later than contemplated, because somebody lacked the courage to say, "Boss, we appreciate your desire but it just ain't attainable within your timing. Will you please refigure how many men and angledozers you would like to have 7 hours later." Delivery of manpower, supplies, and equipment is often delayed because someone failed to realize just how many pieces of transportation equipment would be required and at what time in order to attain the desired time objective. Break-downs and resultant delays occur because someone failed to appreciate the simple fact that with a given amount of transport equipment there is an inevitable percentage of failure. If the objective is to be attained, adequate swing equipment must be on the spot to offset these initial break-downs. With line equipment such as angledozers and tank trucks this failure to calculate probabilities exists, and jobs are planned with no consideration for the equipment break-downs inherent in the operation. Fire lines are lost because the one angledozer provided broke down. Sound application of logistics would have assigned at least two, and perhaps three, to the job. Men are walked energy-destroying miles when simple consideration of the logistical requirements dictated establishment of pack-train camps or perhaps man-pack camps to insure that all the potential energy of the crew was expended upon fire control effort and not uselessly frittered away on walking forth and back to trucks and thereby wasting the most effective hours of the day.

In many respects the application of the art of logistics by the back-country fire fighter of 40 years ago was far superior to the general practice of today. He knew that his fire was in tough country, that he would have a hard time getting to it, and that he would have to do his best with the little he could bring to it. Consequently, his application of logistics summed down to the simple matter of how he could get to the fire the most effective supplies, equipment, and manpower with the few mules available. Today in an era of rubber and gas, with countless trucks and the hope, however fruitless, of more and more trucks and more and more men we have practically lost the art of simplicity in organizing for and executing fire control actions. Our thinking and procedure have become complex and often bog down under their own weight, predicated too often upon the mass movement of hundreds of men and tons of supplies to the nearest point within road distance of a fire. What happens from then on is in the lap of the gods. If the fire stays close to the road, well and good; if it reaches into the hinterland, a catastrophe may result if our application of the art of logistics does not apply all of the technics available in the fields of air, water, truck, mule, and man-back transportation. Yet we do not give men the benefit of planned training in this art.

We watch the clock too closely in determining when shifts should start (6 o'clock breakfast) and fail to appreciate that victory is gained by taking the enemy when he is weak; the important point of having the right forces in the right places at the right time and in the right quantities. We fuss because we cannot have men and supplies at the time that we would like to have them, failing to appreciate that the first element of the fire boss job is to realize just what the availability of these resources is and to plan and replan control action in accordance with these facts, which the logistician must deliver to him coldly and dependably.

This is a brief summation of the elements in the science of applied logistics for which chiefs of staff and others with similar duties have a most important responsibility. It is up to them to know the possibilities of procurement of all the various implements of fire control desired by the fire boss and keep him honestly apprised as to the time that their placement upon the fire line may be positively expected. It is the job of the logistician to give the fire boss the facts about the essentials and thus give him ample opportunity to prepare plans based upon these facts. Altogether too many fires are not controlled within the planned time limits. In the main this failure is much more due to ignoring or not realizing the import of the logistical facts in the situation than to the acts of God in the form of wind, behavior, etc., that are all too frequently blamed.

MOBILE 25-MAN OUTFIT

JOHN B. FORTIN

District Forest Ranger, Ouachita National Forest, U. S. Forest Service

The desirability of a mobile 25-man outfit had been recognized on this forest for several years. Specifically, the features wanted in such an outfit were as follows: (1) Compactness to permit mounting on a standard long base stake-body truck, (2) complete cache of hand tools for 25 or more men, (3) facilities for cooking and serving meals in the field, as close to the fire as possible, (4) emergency rations, (5) communication facilities, (6) water tank, pump, and hose. This need was finally filled during the very dry and hazardous spring of 1943 by attaching 2 fire boxes and a pump and tank assembly to a stake-body truck.

The tank has a capacity of 165 gallons. On it is mounted a live reel with 500 feet of ¾-inch garden hose. At first a hand force pump was used, but this was later removed and a Panama pump with power take-off was installed under the truck cab. A drain on the tank permits filling backpack pumps when other water is not available. This is a very desirable feature in areas where streams go dry during certain periods of the year and water must be hauled to the fire. A 25-foot, noncollapsible intake hose is used for filling the tank.

The contents of the two fire boxes are as follows:

BOX NO. 1

4 double bit axes.
2 brush hooks.
24 council tools.
2 crosscut saws.
6 canteens.

2 hazel hoes.
2 mattocks.
4 timber carriers.
4 potato hooks.
2 shovels.

8 files.
1 camp cook stove.
2 gallons kerosene.
2 first-aid kits.
6 seals.

Pencils, time slips, map, signs

BOX NO. 2

4 backpack pumps.
6 lanterns, kerosene.
4 lanterns, gasoline.
2 electric headlamps.
1 knapsack.
8 canvas buckets.
1 mess outfit, 12-man.

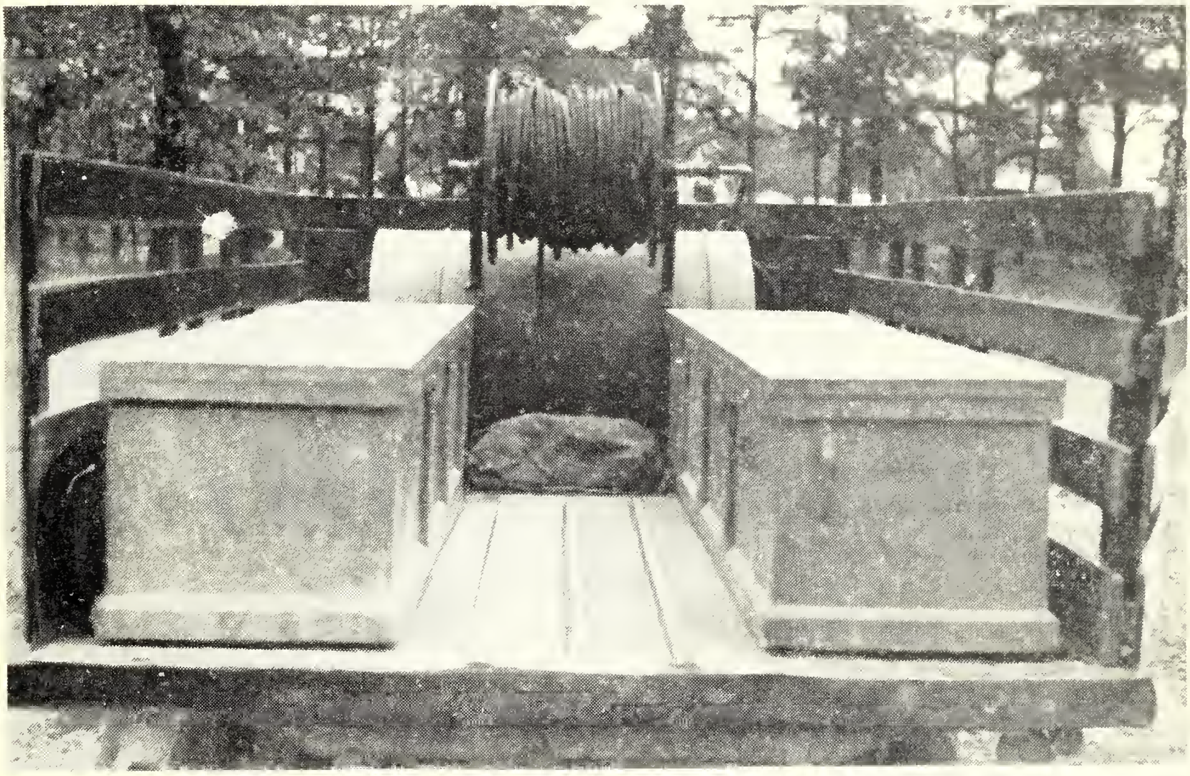
1 roll-top table.
1 fly, tarpaulin.
25 K rations.
25 canned rations for cooking.
1 100-foot rope.
1 portable telephone.

1 portable radio.
1 roll (½ mile) emergency telephone wire
2 wrenches, adjustable.
1 each pliers, hammer, hand saw.

The roll-top table listed in box No. 2 consists of slats of ½ by 1½ by 38 inches to which has been tacked light canvas or other suitable fabric. When rolled out on the ground or on supports, it provides a clean surface on which to serve meals. Because of its roll-up feature, it occupies comparatively little space in the firebox.

Many of the fires on this forest are close to traveled roads or logging roads which give access by truck to at least part of the fire line. This permits placing the crews close to the fire with a minimum of foot travel and feeding them there.

During a period of long drought, a fire occurred on September 17, 1943, in an area of heavy slash on the Mena District. A strong wind blew sparks as much as 150 yards causing spot fires in the dry duff. The ranger had a choice of trying to hold the fire on a very poor logging road at the foot of a slope or falling back to the top of a ridge. He determined to hold the fire at the logging road. The hose and pumper were brought into play to cool the fire as it approached the road so that a line could be built. The numerous spot fires caused by sparks jumping the road were extinguished quickly with the hose. Without the aid of this mobile outfit the fire could never have been held along the rudimentary road. What could have very easily been a 500-acre fire was held to 60 acres. The men were fed right at the fire line with food stocked in the truck cache.



Arrangement of tank, hose reel, and boxes of 25-man outfit. Tailgates are used when truck is in motion.

Another typical fire on which this outfit proved its usefulness occurred on August 20, 1944, on the Mena District. Fuel moisture was down to 4.1 percent and a fresh wind was blowing when a fire was reported in an area of heavy slash and high grass. Only 12 men were available for immediate dispatch. When the crew arrived at the fire it found that an old overgrown logging road paralleled part of the head and one side of the fire. The crew was too small to split into 2 parties because of the intensity of the fire. One hoseman and the truck driver managed to hold part of the head and the side of the fire along the logging road. This permitted the remaining 11 men to be used in force where the truck could not maneuver. Without the truck, the ranger figured he would have lost at least 300 acres. Actual loss was 60 acres.

Other instances have proved conclusively the usefulness and versatility of this equipment since it was first assembled, with the result that similar units have been provided for the other districts on this forest.

A DUAL PURPOSE HAZARD REDUCTION BURNER AND FOAM UNIT

A. B. Everts

Forester, Snoqualmie National Forest, U. S. Forest Service

Hazard Reduction Burner

Many fire control officers are familiar with the hand pump, air-pressured Hauck torch. When working properly the Hauck is a good torch. The principal difficulties are its rapid loss of pressure, which makes frequent pumping necessary, and the clogging of the small discharge orifice.

Believing that the employment of an improved burner and a method of maintaining constant pressure would overcome these faults, the men of the Snoqualmie National Forest constructed an automatic unit.

A 40-gallon, 185-pound test galvanized high-pressure hot-water tank was purchased and hooked up as shown. Nitrogen, an inert gas, was used for pressure. The pressure in the nitrogen tank (2,000 pounds) was reduced to an operating pressure of 35 pounds by the use of a reduction valve. An 80-foot length of ½-inch hose was connected to the burner, a KER-O-KIL model No. 44. This burner, like the Hauck, requires preheating before it will generate properly. The kerosene burns at 2,000° F. and produces a flame 24 by 44 inches. According to the manufacturer, the burner consumes 2 gallons of kerosene per hour. Our tests, however, indicated 1½ gallons per hour as being more nearly correct.

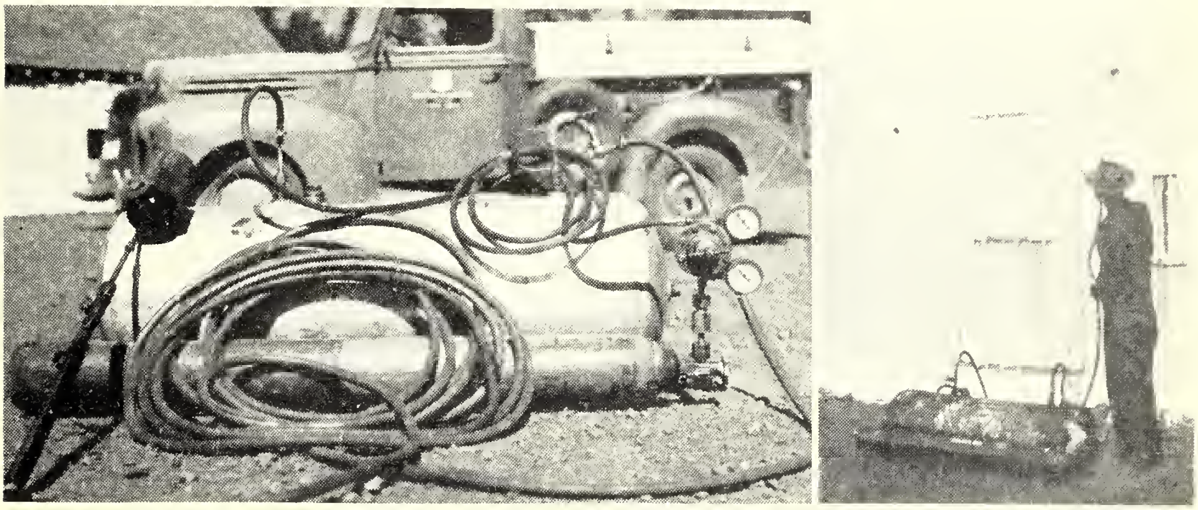
Loaded on a pick-up, or, better yet, a 4 by 4, the unit can be used on most pine operations. It is of value on roadside hazard reduction in the Douglas-fir type. The unit was used hour after hour on slash disposal last fall without any clogging or other difficulties. According to our figures, one 40-gallon tank of kerosene will serve the burner for approximately 60 hours. One cylinder of nitrogen will furnish sufficient pressure to expel three 40-gallon tanks, or 120 gallons total. The cost of recharging the nitrogen cylinder here in Seattle is $1. Thus, the operation cost is less than ½ cent per hour for the nitrogen.

Because of the low rate of fuel consumption, friction loss is negligible. If a burning unit only is desired, a standard 85-pound test tank is sufficient. A 20-gallon tank would operate for approximately 30 hours. In our work the larger, heavier tank was used, however, so the unit could be used for foam during the fire season.

A Foam Unit

In using foam, much higher tank pressures are needed. The friction loss in small hose is high, and to produce good foam, nozzle pressures of 30 to 100 pounds are necessary, with the foam quality increasing at the higher pressures.

The two types of foam in use today are chemical and mechanical. Chemical foam is a powder. The equipment for its use is rather complicated and will not be discussed here. Mechanical foam is a liquid and can be premixed with water at the rate of 6 gallons of solution to 94 of water. A specially designed foam nozzle must be used. This nozzle sets up a whirling motion of the water and foam solution which picks up air at the back end of the nozzle and produces foam. Foam nozzles come in sizes from the small plastic type, used on this unit, to 2½-inch sizes, producing 1,200 gallons or more of foam a minute. At 100 pounds nozzle pressure, a foam and water mixture will produce about 10 times the capacity of the container. That is, a 500-gallon tank truck with a 6 percent liquid foam solution will produce approximately 5,000 gallons of foam.



Left, nitrogen-pressured kerosene-burning hazard reduction unit. Right, the unit converted to foam. The foam clings, smothering the fire and preventing reignition.

In theory, foam is best for oil and gasoline fires since it can be applied quickly in large quantities, blanketing out the oxygen and smothering the flames. Its use on forest fires needs to be more thoroughly tested. David P. Godwin reported on its use in Aerial and Chemical Aids, Fire Control Notes, December 1936. Improved methods of handling foam have been devised since then. The writer is of the opinion that foam has a place in forest fire fighting, especially in the light fuel areas, mainly because of its volume increase. Is 5,000 gallons of foam more effective than 500 gallons of water? If so, how much? These are questions needing an answer.

On account of its cost, foam should not be premixed in the tank truck because then it has to be used. A method of quickly forcing the foam liquid into the tank when needed can be simply devised. Foam prices are quoted all the way from $10 to $25 per 5-gallon can. It has been sold on surplus sales for as low as $1 per can.

Foam has one quality that cannot be overlooked; that is, its clinging characteristic. It can be applied to a wall or other part of a building and it will cling for several hours. The value of this property can best be realized by quoting from The Use of Fog and Foam by Small Fire Departments, by Walter W. Stephen, in the January 1946 issue of Fire Engineering. This article states:

> A hose and chemical truck from an industrial plant went 4 miles out into the country to a cross-roads community in response to a phone call. It was found

that a fire, starting at one end of a row of five small one-story, frame, shingle-roofed dwellings, had involved two, and seemed certain to destroy all of them. There was no source of water, nor any apparent way to fight the fire.

There was, on this piece of apparatus, a 40-gallon foam extinguisher. This was operated, and covered the exposed side and half of the roof of the third house with foam; these surfaces were scorching and smoking and about to "light off." The blanket of foam remained in place and protected and saved this house and the other two dwellings beyond it, while the first two that were on fire burned to the ground. The point about this case is that it was a peculiar and unusual one of the use of foam on a class I fire.

The operating data on the unit as shown is as follows: 2½ gallons of liquid foam solution was poured into the tank and the rest of the tank filled with water and recapped. A small, plastic foam nozzle was substituted for the burner. Pressure was increased to 125 pounds. The foam produced was measured out in 30-gallon garbage cans. The unit operated for 22 minutes and produced 370 gallons of foam. This is at the rate of better than 16.8 gallons of foam per minute with the water consumption at slightly under 2 gallons per minute. There is little mechanically that can go wrong; no pumps or motors; no moving parts. Such a unit, mounted in a pick-up or 4 by 4 should work out well on light fuels.

If nitrogen is difficult to secure, other pressure mediums can be used. Carbon dioxide can provide pressure for the foam unit. It will not operate the burner, however, because so much of the carbon dioxide is absorbed into the kerosene that the mixture will not burn. Compressed air should work with either the burner or the foam. Oxygen should never be used. It is dangerous when used with oil of any kind.

Caught—Three Firebugs.—"On Jakes Branch, Ranger, and looks like 2 sets," the Pilot Mountain lookout reported to the Pisgah Ranger at 9:05 p. m. on April 14, 1946. At 9:10 p. m. the lookout reported 2 more fires and at 9:15 p. m. another 2. In all a total of 10 fires were set over a distance of 4 miles. Crews quickly suppressed the fires and the damage caused by all of them was small, but the fact that firebugs were loose in the woods during a period of high fire danger caused considerable apprehension.

By 1 p. m. on April 15, the ranger had called all crews in from the field to stand by at the depot. At 2:15 p. m. the Pilot Mountain lookout reported 2 fires set on the Rosman Road, and at 2:25 p. m. 2 more; over a distance of 10 miles a total of 8 fires were set along this road. Again quick suppression kept the fires small. At 7 p. m. 2 more fires were set along the Rosman Road, and at 9:15 p. m. 2 more fires were set in the Jakes Branch area. The last 2 burned 8 acres. The 22 fires burned 30 acres of National Forest land, and suppression costs amounted to $198.

But the fire setters, whom we will call X, Y, and Z, had been careless. It was found that X's car had been identified on Jakes Branch on April 14, and that Y and his car had been identified near the fires on April 15. The ranger sent for the F. B. I. On April 16 Agent Ingram and the Pisgah Ranger questioned the drivers of the extractwood trucks along the Rosman Road and received the following signed statements:

First driver: "I passed Y and Z near Alligator Rock and just above where I passed them was a small fire which me and my helper put out."

The helper: "I was with the first driver when we passed Y and helped fit the fire, but I was a deserter and have a dishonorable discharge from the Army so what I seed ain't no good."

Second driver: "I passed Y and Z at 6:30 p. m. on April 15, and then passed two fires that had just been set."

Third driver: "I passed Y and Z about 6:15 p. m. and they were out of their car, which was parked alongside the road. When I came past this same place next morning, I found a fire had been set at this spot."

(*Continued on p. 21*)

KILLING BRUSH WITH 2,4-D

ROBERT K. BLANCHARD

Forester,[1] California Forest and Range Experiment Station [2]

2,4–D is a member of the group of new wonder chemicals which includes DDT, penicillin, and the sulfa drugs. They all have remarkable powers to kill specific organisms which are either harmful or troublesome to mankind, but they all have their limitations. Certain serious diseases are cured by the drugs as if by magic. With DDT flies can be driven from their favorite habitats, and dandelions wither and die if sprayed with 2,4–D. But people still die of infectious diseases, we still have hords of insects, and we can safely predict that we will continue to have troublesome weeds and brush.

2,4–D is the abbreviated name of a chemical compound called 2,4–dichlorophenoxyacetic acid, but the pure acid is not much used in practice because it is only slightly soluble in water. Instead, more soluble compounds are prepared with the acid, and for a given content of the parent acid they appear to be equally effective.

The most outstanding properties of 2,4–D are its toxicity in very small quantities and the fact that the chemical stimulus moves downward in the plant along with food manufactured in the leaves. Mustard seedlings in grain fields can be killed with as little as a pound of 2,4–D per acre without affecting the grain. 2,4–D is noninflammable, noncorrosive to equipment, and is nonpoisonous to animals; but the oil solutions may irritate the skin of some individuals. In addition, it is easy to handle and use as compared with certain other herbicides, and it does not deteriorate under normal storage conditions.

Just why 2,4–D is so poisonous to plants and why it kills some plants and not others is a mystery. A few days after susceptible herbaceous plants are treated with 2,4–D, the leaves and stems twist and curl. In a few more days the stems and even the roots swell and split as a result of the abnormal growth. In about a month the plants are usually dead. Only a few woody plants show these so-called formative effects to any extent.

2,4–D does have a sterilizing effect on soil regardless of statements to the contrary which appear on the labels of some products. It is only temporary, however, for the chemical is effectively leached out by a few inches of rain.

---

[1] Acknowledgment is made to L. P. Winslow of the Blister Rust Investigations office at Berkeley, Calif., who conducted the fall field tests and to H. R. Offord, in charge of that office, for his hearty cooperation on this project

[2] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California, at Berkeley, Calif.

Experimental Work

In view of these remarkable properties of 2,4–D, the Experiment Station in the fall of 1945 undertook a study of the effect of 2,4–D on the brush species of California. The purpose of the initial phase of the experimental work was to determine over a representative geographical range what species of brush can be killed by 2,4–D. One or more test sites was selected on the Angeles, San Bernardino, Sierra, Eldorado, Lassen, Shasta, and Klamath National Forests to include about 40 kinds of brush. The work was started in the fall of 1945 and was continued after the start of new growth in the spring of 1946. Application of the spray was made by square-rod plots at the rate of 10 gallons per square rod. The sodium salt of 2,4–D was used in concentrations of 0.04, 0.08, and 0.12 percent acid. The spray equipment consisted of a tank truck equipped with a power take-off pump. A pressure of 100 to 125 pounds was used with a No. 5 disk nozzle which gave a rate of delivery of about 1 gallon per minute.

The results of the fall work were poor because the brush was then in a state of dormancy. The spring spraying killed the leaves of most species treated. Even in the case of those classed as resistant, the succulent growth of the current season was killed regardless of the stage of development. Some nonsprouters were killed outright, but the sprouters sent out suckers from the crowns and the bases of the stems. In no case was a 100-percent kill of foliage obtained.

Table 1 is a list of species with common and scientific names giving the susceptibility of each to 2,4–D as indicated by the tests conducted in May and June 1946. High susceptibility means that 80 percent or more of the leaves were killed by the strongest spray although in some cases the stems were still green 3 months after treatment. Resistant species are those in which the old leaves were not affected by the treatment. Those of moderate susceptibility lie somewhere between these limits.

TABLE 1.—*Susceptibility of the foliage of California brush species to 2,4-D*

SPECIES	SUSCEPTIBILITY to 2,4–D
Adenostoma fasciculatum (greasewood or chamise)	High.
Aesculus californica (California buckeye)	Do.
Amorpha californica (California amorpha or mock locust)	Resistant.
Arbutus menziesi (Pacific madrone)	High.
Arctostaphylos patula (greenleaf manzanita)	Moderate.
A. viscida (whiteleaf manzanita) [1]	High.
Artemisia arbuscula (low sagebrush) [1]	Do.
A. cana (silver sagebrush) [1]	Do.
A. tridentata (big sagebrush) [1]	Do.
Baccharis pilularis (kidneywort baccharis or coyote brush)	Do.
Castanopsis chrysophylla (giant evergreen chinquapin or golden chiquapin).	Resistant.
Ceanothus cordulatus (mountain whitethorn ceanothus)	High.
C. crassifolius (hoaryleaf ceanothus)	Do.
C. cuneatus (buckbrush ceanothus) [1]	Do.
C. divaricatus	Do.
C. integerrimus (deerbrush ceanothus)	Do.
C. prostratus (squawcarpet ceanothus)	Resistant.
C. velutinus (snowbrush ceanothus or tobacco brush)	Moderate.

Table 1.—*Susceptibility of the foliage of California brush species to 2,4-D*—Con.

Species	Susceptibility to 2,4-D
Chamaebatia foliolosa (bearmat)	High.
Cytisus scoparius (Scotch broom)	Do.
Eriodictyon californicum (California yerbasanta)	Do.
Garrya sp. (silktassel or quinine brush)	Do.
Lithocarpus densiflora (Tanoak)	Do.
Pachistima myrsinites (myrtle or Oregon boxwood)	Resistant.
Photinia arbutifolia (Christmasberry or toyon)	High.
Pinus ponderosa (ponderosa pine)	Moderate.
P. sabiniana (Digger pine)	Resistant.
Prunus emarginata (bitter cherry)	Do.
Pseudotsuga taxifolia (Douglas-fir)	Moderate.
Quercus chrysolepis (canyon live oak or maul oak)	Do.
Q. dumosa (California scrub oak)	High.
Q. kelloggii (California black oak)	Do.
Q. wislizeni (interior live oak)	Resistant.
Rhamnus californica (California buckthorn or coffee berry)	High.
Rhus diversiloba (Pacific poisonoak)	Do.
R. laurina (laurel sumac)	Do.
R. trilobata (skunkbush sumac or squaw bush)	Do.
Rubus ursinus vitifolius (grapeleaf California dewberry)	Resistant.
Salix sp. (willow)	High.
Sambucus glauca (blueberry elder)	Do.
Umbellularia californica (California laurel or bay)	Moderate.
Vitis californica (California grape or wild grape)	High.

---

[1] Nonsprouters which were killed.

The results obtained in this preliminary work are not satisfactory as an answer to the question, "Can brush be killed with 2,4-D?" They are nonetheless encouraging, for although all species sprouted, all individuals did not. Low California scrub oak (*Quercus dumosa*), for example, had only a few feeble sprouts 3 months after treatment with 0.12 percent spray. The problem resolves itself into one of finding out when, what, where, and how to treat.

The following recommendations are made on the basis of the work reported here and the work of other investigators in the East. It is along these lines that future work will be done at this Station.

Procedure for Treating Brush With 2,4-D

1. What to treat:

a. Sprouting species.—Spray only low growth (not over 3 feet high) or stumps. Higher brush should be chopped followed by treatment of the stumps. 2,4-D does not move downward effectively over distances in excess of 3 feet.

b. Nonsprouters.—Susceptible species of any size can be killed, but if the brush is high, chopping in the first place is probably a more satisfactory method of control. The best results have been obtained on brush 3 to 4 feet high because it is easier to spray thoroughly. Thorough spraying of tall brush is difficult to accomplish and expensive in labor and material.

2. How to treat:

a. Brush (*sprouting or nonsprouting*).—Thoroughly spray foliage with a water solution of 0.2 percent acid which is 2,000 parts per million. (See tables 2 and 3 for mixing solutions.) *Every Leaf Must Be Wet With Spray.* It is necessary to add a wetting agent to the spray so that the drops will not roll off the leaves. For small-scale work, "Vel," "Dreft," or "Swerl," nationally advertised soap substitutes, are satisfactory wetting agents when used at the rate of about 1 cupful to 5 gallons of spray.

b. Stumps.—Wet the freshly cut surfaces with 1.0 percent solution in kerosene using a 2,4-D ester (described below). Only kerosene should be used as a carrier because it is the least poisonous (of the regular petroleum products) to plants. If a toxic oil (virtually all petroleum products except kerosene) is used, the oil itself will quickly kill the conducting tissues and the 2,4-D will have little effect. For treating stumps in trail work, 10 percent kerosene solutions can be applied with a paint brush or a household fly sprayer. Very little is required, but the sapwood should be thoroughly treated.

3. When to treat:

a. Brush.—Brush must be treated while it is in full leaf and physiologically active. This is usually between the end of the flush of spring growth and early July. The best time is shortly after the end of the spring growth. Spray in a warm period when the daytime temperatures are above 70° F. and when the foliage is dry. Rain which occurs more than 6 hours after treatment will have little effect.

b. Stumps.—Stumps should be sprayed or painted immediately after cutting. If, however, some time has elapsed, the bark should be frilled all the way around with an axe and the chemical applied to these fresh cuts as well as to the old cut surface. The lower the stumps are cut, the better. The effective season for treating stumps is not known, but it probably extends from the beginning of the growing season to midsummer.

A certain amount of sprouting is to be expected after any chemical treatment of brush. Such sprouts should be given a follow-up treatment with water spray within a few weeks after they appear.

Commercial 2,4–D Preparations

2,4-D is manufactured in two general chemical forms, salts and esters. The salts (sodium, ammonium, and triethanolamine) are soluble in water. The esters (methyl, isopropyl, and butyl) are soluble in oil and are marketed in oil solutions containing emulsifying agents. They can therefore be used with either oil or water as a carrier.

The cost per pound of 2,4-D acid in the form of salts is about half as much as in the form of esters. The triethanolamine salt is the cheapest of all and is available in solutions containing 20- and 40-percent acid by weight. The other two salts are sold in the form of powders. One product contains 60 percent acid by weight, another, 77.5 percent. The 60 percent salt contains a wetting agent but in insufficient amount for glossy-leaved plants. The esters are all sold in liquid form. The methyl ester is available with 20 percent acid content by weight, the butyl ester with 32 percent. (The latter contains 40 percent of the ester compound.)

These products, except the isopropyl ester which is not yet available in commercial lots, are sold in wholesale quantities by the manufacturers and are generally available at chemical and spray material supply houses. An increasing number of preparations containing 2,4-D are also sold in seed and hardware stores under a variety of trade names.

Special wetting agents for spray work are available. They are all good but one should be sure that they can be used with 2,4-D. Some of those containing "stickers" gum up tank and spray equipment and are not recommended. "Tergitol" is a satisfactory product. Directions for use are given on the packages, but if the 2,4-D product already contains a wetting agent, less of the supplementary spreader should be used. Too much wetting agent causes excessive drip from the leaves and is therefore wasteful.

TABLE 2.—*Weight in ounces according to acid content of 2,4-D product required for 0.2 percent spray solutions* [1]

Volume (gallons)	Weight by 2,4-D acid content percents—				
	20	32	40	60	77.5
	Ounces	*Ounces*	*Ounces*	*Ounces*	*Ounces*
5	6.5	4.15	3.3	2.20	1.7
10	13	8.3	6.5	4.4	3.4
50	64	41.5	32	22	17
100	128	83	64	44	34

[1] For a 1-percent spray, use 5 times the weight listed for the desired volume.

TABLE 3.—*Approximate amount of 2,4-D liquid product required for mixing 0.2 percent spray solutions*

Volume (gallons)	2,4-D acid content	Cups of 2,4-D product	Volume (gallons)	2,4-D acid content	Cups of 2,4-D product
	Percent	*Number*		*Percent*	*Number*
6	20	1	6	40	½
5	32	½	7	[1] 60	½

[1] Powder form.

The recommendations made here are for the general guidance of field men who are planning limited experimental work. Practical ways in which 2,4-D can be applied to the general problem of brush-control cannot yet be well defined. Still to be determined are the concentrations and rates of application as well as the best season for treatment for each species. It is expected that spraying with concentrated solutions at a low volume rate per acre will prove cheapest, but this method requires special equipment. Some tests have been made by others on brush using 2,4-D as a dust, but the results have not been as good as with sprays.

In spite of the mediocre results obtained to date, the outlook for successfully controlling certain kinds of brush with 2,4-D is good. The Bureau of Entomology and Plant Quarantine has obtained very good results with certain species of *Ribes* and are planning to use considerable quantities of 2,4-D during the 1947 season for *Ribes* eradication work. The price of the chemical is an obstacle at present, but it is almost certain to go down as production increases.

REGION 6 EQUIPMENT DEVELOPMENT LABORATORY

THEODORE P. FLYNN
Engineer, North Pacific Region, U. S. Forest Service

The Equipment Development Laboratory at Portland, Oreg., had its start on October 4, 1935, when F. A. Silcox, then Chief of the Forest Service, approved a proposal by T. W. Norcross, Chief of the Division of Engineering, that suggestions for equipment improvement and development be referred to the Chief's office for consideration, and that approved projects of Service-wide benefit be financed.

The laboratory began work in 1937, under the supervision of the Regional Engineer in Portland. Concerned primarily with road construction and maintenance equipment, the work included testing, improving and developing equipment for fire control and other Forest Service work.

For several years, construction of models as well as design was done by laboratory engineers and mechanics. Later the laboratory personnel and equipment were moved to Sellwood, in south Portland, where the equipment repair shop is located. Construction work is now done by the shop mechanics, the laboratory development work being confined to design and testing. However, a section of the shop is devoted especially to work on laboratory projects.

Over the years the laboratory has built up a technical library, and it is on the mailing lists of a large number of firms, who contribute up-to-date material regularly, particularly on metallurgy and mechanical design. The library and the advice of laboratory engineers are, of course, available to departmental shop personnel and others.

Objectives of the laboratory are (1) to promote commercial manufacture of successfully developed items, so they will be available for purchase at lower prices by the Forest Service and others needing them; and (2) to contribute to the improvement of commercial equipment on the market, so that it will better meet the requirements of the job.

Problems encountered at the laboratory are of wide variety, relating to many kinds of equipment. Called the largest logging tractor in the world, a 46,500-pound giant popularly known as the "Tomcat" was designed, constructed, and put into successful operation by laboratory personnel. At the other extreme is the "Beetle" trail-tractor,[1] weighing less than 2,000 pounds, probably the smallest bulldozer-equipped full-crawler tractor ever constructed. In between is the larger trail tractor,[2] about 4,500 pounds, which was one of the earliest developments.

---

[1] FIRE CONTROL NOTES, July 1946, p. 1.
[2] FIRE CONTROL NOTES, April 1940, p. 93.

Throughout a period of nine years, the laboratory has handled or taken part in over 300 development projects. Many, of course, were small items of local interest or need. The "batting average" on these projects has been high; only a little over 10 percent were failures because they did not meet requirements or failed to receive popular approval.

The largest manufacturer of crawler tractors in the country has adopted some of the principles of the "Tomcat" on a new test model now in the field. The "Beetle" is already in quantity production, with prospects of a much larger market outside than inside the Forest Service. And the Oliver Corp. is now in quantity production of a light tractor, patterned after the original trail tractor, which has sufficient ruggedness, power, and stability for fire line construction. There is considerable demand for the heavy-duty brush mower outside the Forest Service, but it is not yet being manufactured commercially, although a mining company in Alaska has constructed brush mowers for its own use from laboratory plans.

Rock blade development at the laboratory stimulated the production of a land-clearing blade now being manufactured and sold in large numbers. Laboratory engineers have also helped develop and improve power chain saws, now in wide use by loggers. Three of the most successful chain saw manufacturers made many of their early tests in the laboratory yard and were aided by suggestions from laboratory engineers.

During the war, the Army found two important laboratory developments valuable. When the need arose for a light, narrow tractor to be transported by airplane, Forest Service trail tractor plans and a model were quickly made available; the airborne tractor, known as the Clarkair, was soon in production and more than 8,000 were manufactured under Army contracts. The snow-tractor, developed for use on Mount Hood, was tested by the Army along with commercial makes, and a contract for similar snow-tractors was let to a Portland manufacturer.

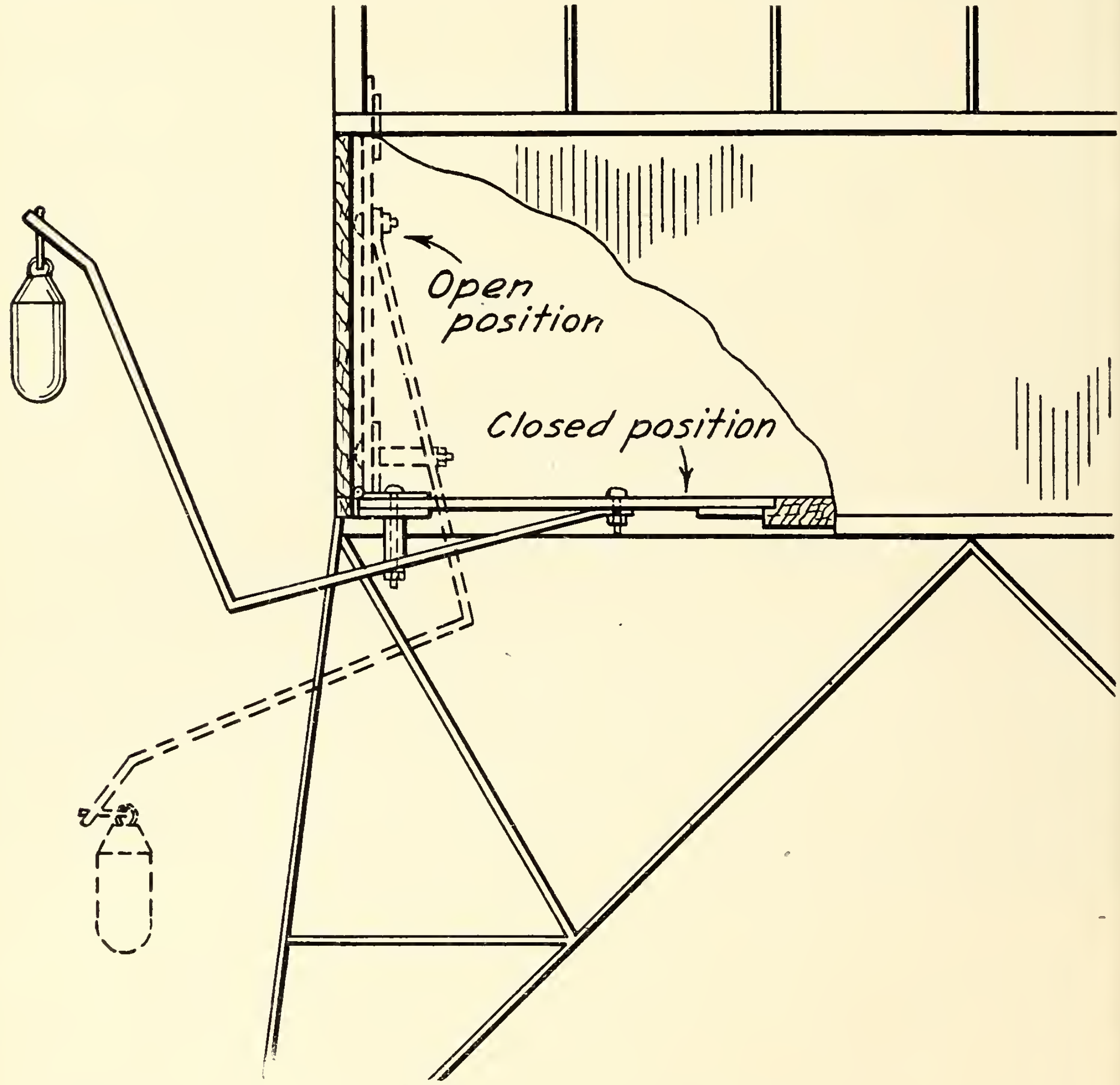
In addition to its work for the Divisions of Engineering, Fire Control, Timber Management, and Range Research during the past 2 years, the laboratory has been called upon for advice by foresters and loggers in various parts of the country. This service involves the writing of many advisory letters every year. Each development project must, of course, be financed by definite allotment of funds, but it is possible to furnish information and advice without cost if they do not involve work on the drafting board.

TOWER DOOR COUNTERWEIGHT

Favre L. Eaton

Assistant Supervisor, Helena National Forest, U. S. Forest Service

Opening the trap door in the floor of a lookout tower cab has been made easier and safer by the installation of a simple counterweight suspended on a side arm. Being able to open with one hand the overhead door of a lookout cab 20 to 100 feet off the ground is a big help to a towerman, especially when carrying anything. The door will remain open or closed, as desired, when the counterweight is used.



Such a door opener was designed by Lookout Ralph F. Eaton, made in a local shop at a cost of $3, and installed in a few minutes. He used an inverted 5-inch motor piston as a counterweight in order that extra weights could be placed inside the piston if any were needed. It is believed iron sash weights would prove the cheapest and best appearing weight.

The device consists of a rigid arm constructed of 2-inch angle iron welded at a 90° to 100° angle, one end bolted to the underside of the trap door, and the other end, on which the weight is fastened, extending upward and outward alongside the lookout cab. The horizontal iron bolted to the trap door is 2 feet in length, and the nearly vertical iron holding the weight is 3 feet long from angle to weight fastening. A window-sash weight of 8 or 10 pounds is fastened to the upright angle iron by the use of an eyebolt. For a very windy lookout, an additional angle iron should be welded to the arm near the angle formed by the horizontal and vertical irons, and bolted to the door as a side brace to offset vibration. Aluminum paint can be used to dress up the device and protect it against corrosion.

(Continued from p. 12)

The F. B. I. agent and Ranger then proceeded to the home of Z and in the presence of his father took down his sworn statement that he was with Y when Y set the fires on the 15th and that both X and Y had asked him to go with them and set fires on the night of the 14th. Further investigation found that another witness had identified X's car on April 14 as the only car that had passed where the fires were set.

On the 17th Federal warrants were taken for X and Y and both men were arrested and placed in jail. On the 18th trial was held before U. S. Commissioner Kizer in Brevard, N. C. Z could not be found, and the trial was postponed until May 3. Again Z could not be found and the trial was held without him. The Commissioner placed Y under $1,500 bond to appear before Federal Court in May. A true bill was obtained for X before the Federal grand jury, but at the May court Z again failed to appear. On May 18 after court adjourned Z came before Commissioner Kizer and said he had been "hid out" by X, Y, and a brother of theirs. The Commissioner took a signed statement and mailed it to the District Attorney.

An F. B. I. agent was sent out to arrest the three brothers for intimidating a Government witness. At the trial, Z denied everything he had said in his sworn statement, and the Commissioner dismissed the case. Again a true bill was obtained from the grand jury and the three brothers were charged with intimidating a Government witness. At the November term of Federal Court everybody but Z appeared; this time he was in Florida. The Government proceeded to call the case without him. However, X and Y were getting uneasy. A jail sentence looked almost certain for Y, and possibly for X, so their lawyer asked to plead Y guilty and take a nolle contendre for X, if the court would fine them $200 and place them on probation instead of sending them to jail. The District Attorney accepted this compromise and the case never came to trial. Y paid a $200 fine (cost of suppressing fires) and was given a 6 months' jail sentence suspended on 18 months' probation. X received the same sentence and probation. The third brother pleaded guilty to the charge of intimidation of a Government witness and was also given a 6 months' jail sentence suspended for 18 months.

Lawyer fees, fines, and the time spent fighting the charges in this case cost the brothers more than $1,000. The probation sentence should keep them well behaved for some time to come. Z still has to face a charge of perjury, as he denied the statement sworn to before the U. S. Commissioner. He also is liable for $1,000 bond for not appearing in Federal Court. The fact that a signed statement is not usable as evidence when denied by the witness under oath, caused considerable work in rebuilding the case, but this illustrates that justice can be obtained if a case is built up and fought regardless of adverse conditions.—Bill Huber, *Ranger, Pisgah National Forest.*

A FOREST FIRE TRUCK

William H. Smith

District Forester, Pennsylvania Department of Forests and Waters

Forest District No. 14, which is also known as the Cornplanter Forest District, comprises the five northwestern counties of the Commonwealth of Pennsylvania, with headquarters in Warren. As the district does not contain any State forest land or parks, it is termed a forest protection district. For this reason the personnel assigned to the district are able to devote considerable time and effort toward the development of new protection ideas, techniques, and equipment. This article deals with the development and ultimate use of a forest fire truck of which the Department of Forests and Waters can be justly proud.

In the fall of 1942 a ½-ton pick-up truck of the Civilian Conservation Corps' surplus was assigned to this district. Although we had need for the truck as a pick-up, we felt it could be more usefully employed in fire-control work if it were equipped primarily as a forest fire truck.

As is the usual case in building something new, it is built, rebuilt, and changed until you arrive at the product desired. The same was true with this fire truck. It was originally equipped in 1943, at which time a Panama pump was installed, together with the connections to a 110-gallon rectangular tank located directly behind the cab in the truck bed. The 300 feet of ¾-inch hose was carried in a box directly behind the tank. Four spray tanks or cans were carried on the right side, as they are at present.

Later, a false floor was installed. Sufficient tools for 15-man crew were stored under the floor, a gas tank and a tool box on top. A crosscut saw was fitted in slots under the spray tank shelf on the right side of the truck.

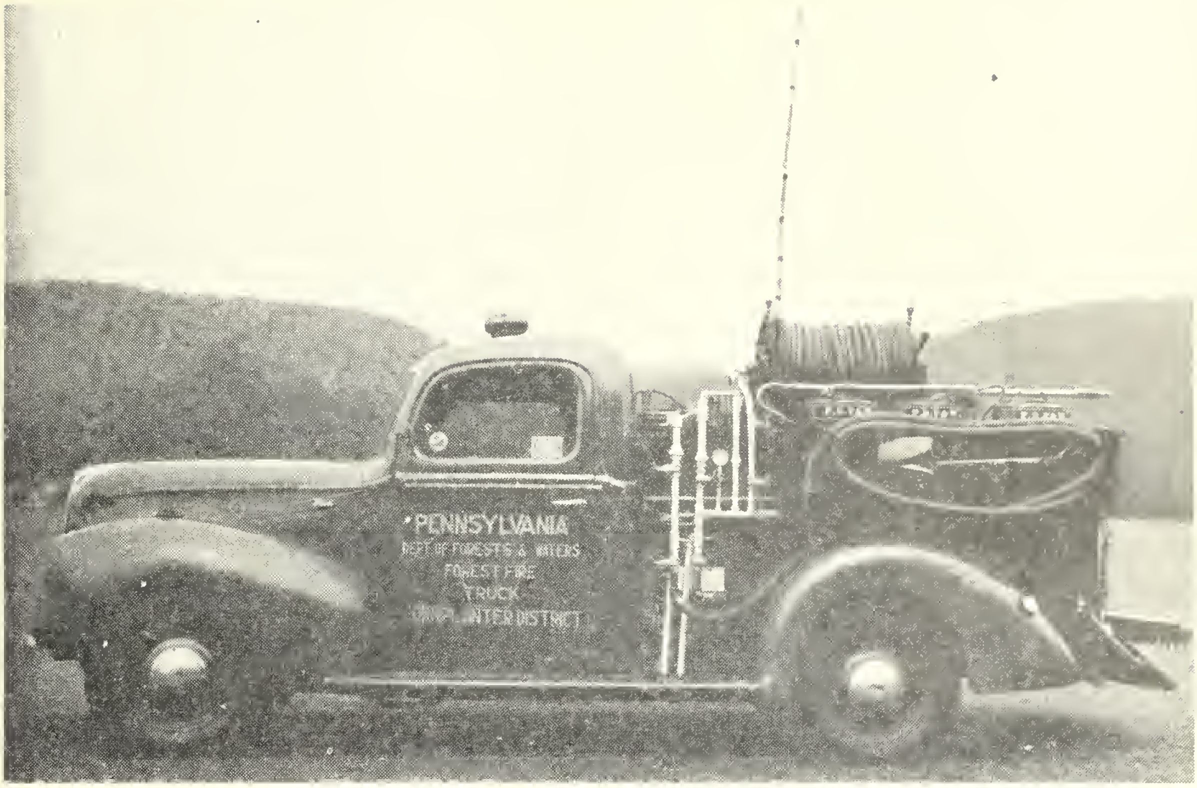
In 1945 the truck was outfitted with a live reel, a siren on top of the cab, and red blinker lights on each of the front fenders. In addition, a shelf for three more spray tanks was put along the left side of the truck, and two additional tanks were placed in the bed of the truck.

At the present time the truck is equipped with the following:

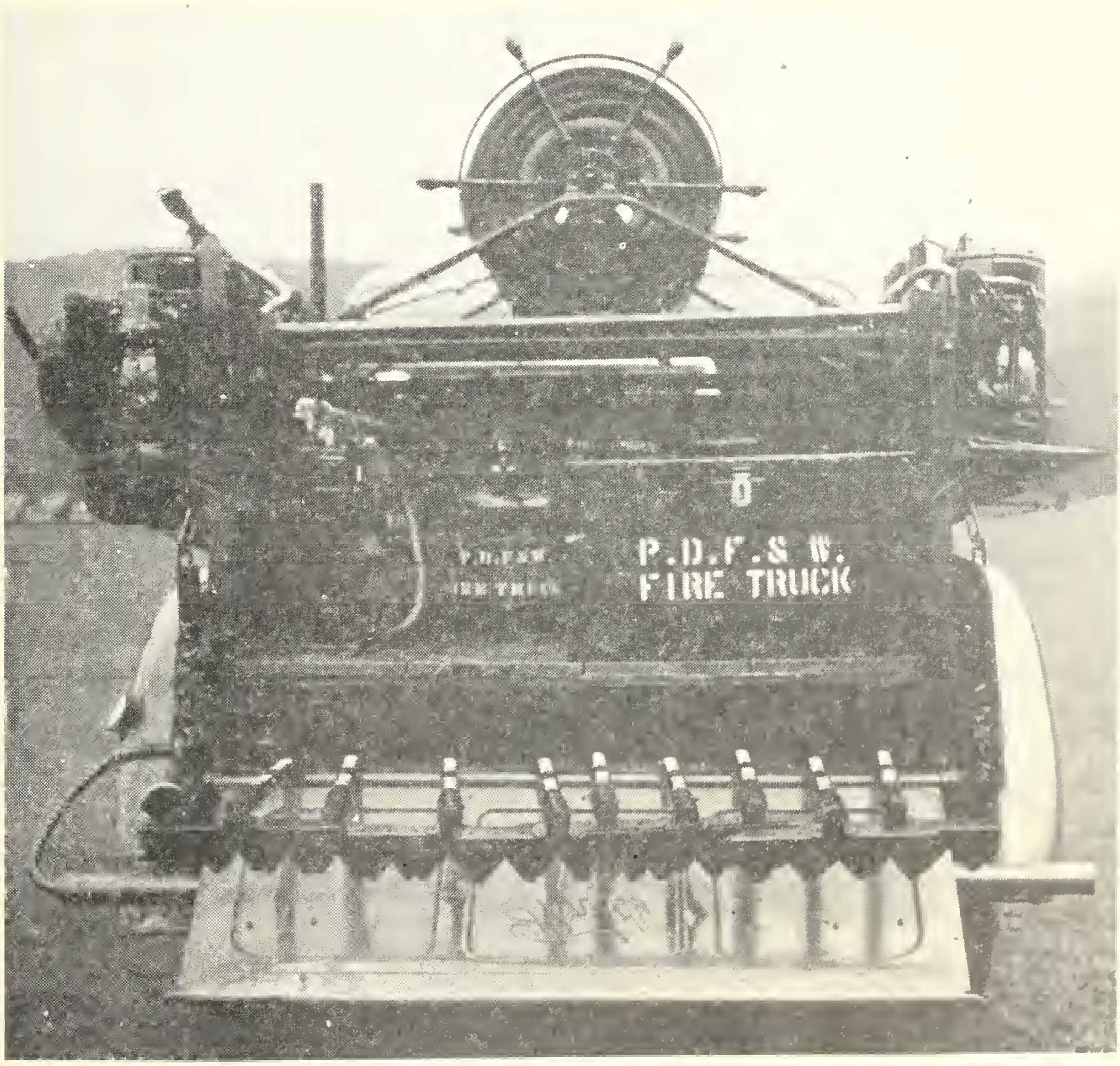
1 Panama pump.
1 110-gallon water tank.
400 feet of hose (100 feet of 1 inch and 300 feet of ¾ inch).
7 Indian spray tanks.
2 Parco spray tanks.
10 Rich rakes.
2 double-bitted axes.
2 brush hooks.
1 crosscut saw.
1 short-handled, round-pointed shovel.
2 dozen fusees (back-fire torches).
12 carbide lights and caps.
2 kerosene lanterns.

It also has a bamboo mast used to string up the aerial for the portable radio assigned to the truck. It is expected that in the near future permanent short wave radio equipment will be installed in the truck.

The Panama pump is connected so that it can pump directly out of a stream or from the 110–gallon tank, through the live reel to the hose, or from the stream to fill the tank. It is equipped with a pres-



One-half-ton pick-up equipped with 110-gallon tank, live reel, aerial mast, etc.



Rear view showing placement of spray tanks, boxes, rakes, etc. Note false floor which provides storage space for long-handled tools.

sure gage and a pressure relief valve. Ordinary valves, such as are used on inner tubes, were placed on both the intake and exhaust lines so that all water could be removed from tank, lines, and hose by the use of compressed air.

It is possible to fill spray tanks at the read end of the truck by means of a ¾-inch pipe, installed at the bottom of the 110-gallon tank and reaching to the rear end of the truck. At this point a valve and short hose are attached.

This truck, as it now stands, was outfitted at a nominal cost. The only materials purchased were the live reel, miscellaneous pipe, valves and gages, siren, blinker lights, and overload springs. The Panama pump and hose were obtained from another piece of equipment. The 110-gallon tank had been built by the N. Y. A., and the tools included were standard fire tools, already stocked by the Department of Forests and Waters. Most of the other materials used to outfit the truck were salvaged from worn-out equipment.

Most of the credit for the design, actual work of construction, and outfitting of the truck goes to Forest Inspector Jay S. Pees and the various district foresters under whom he served while the pick-up was being transformed into a fire truck.

The following summary of statistics from the records on the use of the truck during the 1946 spring fire season show that the truck has justified its existence in many respects:

It was used on 31 fires, during which time it was driven a total of 348 miles.

The pump and hose were used 20 times, and an average of 220 feet of hose was laid at each fire.

A total of 1,220 gallons of water was used from the tank, or an average of 60 gallons per fire.

On the 20 fires where the pump, hose, and tank were used, the total area burned was 25 acres, or an average of 1.25 acres per fire. Many of these fires were in places where the quick action of the fire truck prevented large fires from occurring.

Spray tanks were used on 16 of the fires, and rakes and other equipment on 9 fires.

Six buildings were saved at several of the larger fires by keeping the fire from the vicinity of the buildings.

The truck was also used to assist the fire department in combating local grass fires in Warren.

In addition to the work on actual fires, it has a prevention value that cannot be calculated. It is used as a part of the exhibits of the Department at local fairs, etc. Its very existence has done much to carry forward the work of forest fire prevention in this district.

We have learned from experience that the main fault is that the truck itself is not large or heavy enough to carry the necessary equipment. This ½-ton pick-up is not a good type of truck for this purpose. The transverse type of springs tends to cause undue sway when turns are made and is a factor that we have been unable to correct. Heavier springs were installed but they failed to give the necessary stability. The wheels have had a tendency to break when the truck is subjected to travel over rough terrain. The type of truck we believe would be much more satisfactory is a ¾- or 1-ton truck with dual wheels on the rear, and, if possible, a four-wheel drive. Such a truck equipped in the same manner as the one we now have, would be an ideal fire truck for use in forest fire control in this district.

Although most of the equipment on the truck is demountable, the necessity of having a live reel, tank, and hose semipermanently attached to the truck, limits its use for other purposes, except light hauling and transportation. By semipermanent, I mean that it can be removed if necessary, but does entail considerable work.

This district is fortunate in having more than one forest fire truck in our forest protection organization. Many of our volunteer fire departments and one of the large oil industries have trucks outfitted somewhat like the one described here and used primarily for forest fire control work.

We will be pleased to receive comments on our fire truck, and if additional information concerning it is desired, we shall endeavor to supply it. We feel we have an excellent unit, but realize improvements can always be made.

Alaska Helicopter "First."—On July 12, 1946, the Alaskan Fire Control Service, Bureau of Land Management, used a Sikorsky helicopter in transporting men and equipment to a fire located on the south side of the Tanana River, some 26 miles southeast of Fairbanks, Alaska. The brush and grass fire, starting on an Army bombing range, was inaccessible by foot travel, boat, or regular airplanes. Occurring during a prolonged dry period, the fire quickly grew to class E size and seriously threatened a stand of good white spruce timber along the Tanana River as well as considerable wild game and fur animals. In line with a cooperative agreement between this Service and the U. S. Army Air Force personnel at Ladd Field offered the use of their helicopter to the District Ranger at Fairbanks, Theodore R. Lowell. A shuttle service carried 14 men and their equipment into the fire, flying 7 minutes each way and carrying 2 small men or 1 large man with backpack cans and small tools each trip. Flown into the fire in the late afternoon of July 12, the men brought the fire under control in the early morning of July 13. Without the helicopter to move men and equipment, this Service could not have taken any action whatsoever on the fire. It is felt that although the helicopter is at present a very expensive piece of equipment, its use can be more than justified in a country such as Alaska where the population is small and scattered, transportation routes few, and communication facilities inadequate.—Roger R. Robinson, *Acting Chief, Alaskan Fire Control Service, Bureau of Land Management, Department of the Interior.*

VIRGINIA'S USE OF AIRPLANES FOR FIRE CONTROL

HUNTER H. GARTH

Chief, Division of Forest Protection, Virginia Forest Service

The airplane was first used for fire control in Virginia in the southwest district during the spring of 1945, when a few flights were made by the Civil Air Patrol. These flights were made chiefly by the District Forester in inspecting and supervising the control of going fires. It was found that air observation was effective for this type of work, since the progress of the fire, quickest means of access, and other factors could be readily determined. Break-overs and break-over possibilities also proved to be very easy to detect from the air.

By the time the fire season was over the information had spread over the district that the Virginia Forest Service was using airplanes to spot fires and to catch forest fire law violators. This grapevine element later proved to be the most important factor in the air patrol service and has a tremendous prevention value. The psychological effect of knowing they could be observed from a few hundred feet in the air in otherwise inaccessible areas did a great deal to destroy the feeling of security hitherto enjoyed by illegal brush burners and other forest law violators.

In 1946 air patrol was used on scheduled flights in three districts and occasional flights in two of the other districts. From the few flights made in 1945 it was believed that the potential possibilities were much greater in detection and prevention than in suppression of fires. Therefore the patrols during the last two fire seasons were used principally on those phases of fire control. The days the planes were flown were tied in as closely as possible with the fire weather reports. Flights were made only on class three, and higher, days; but on several days of high class danger weather the wind velocity was such that the pilots would not take the planes up. Consequently on those days it was necessary to rely entirely on lookout towers for detection. For this reason and the cost of operation, the airplanes can only supplement the detection furnished by the towers.

The normal altitude flown in the Piedmont and Tidewater was approximately 1,200 feet, at which height the horizon was generally 36 miles. In the western part of the State the altitude varied with the height of the mountains. Under normal conditions the cruising speed was 75 miles per hour.

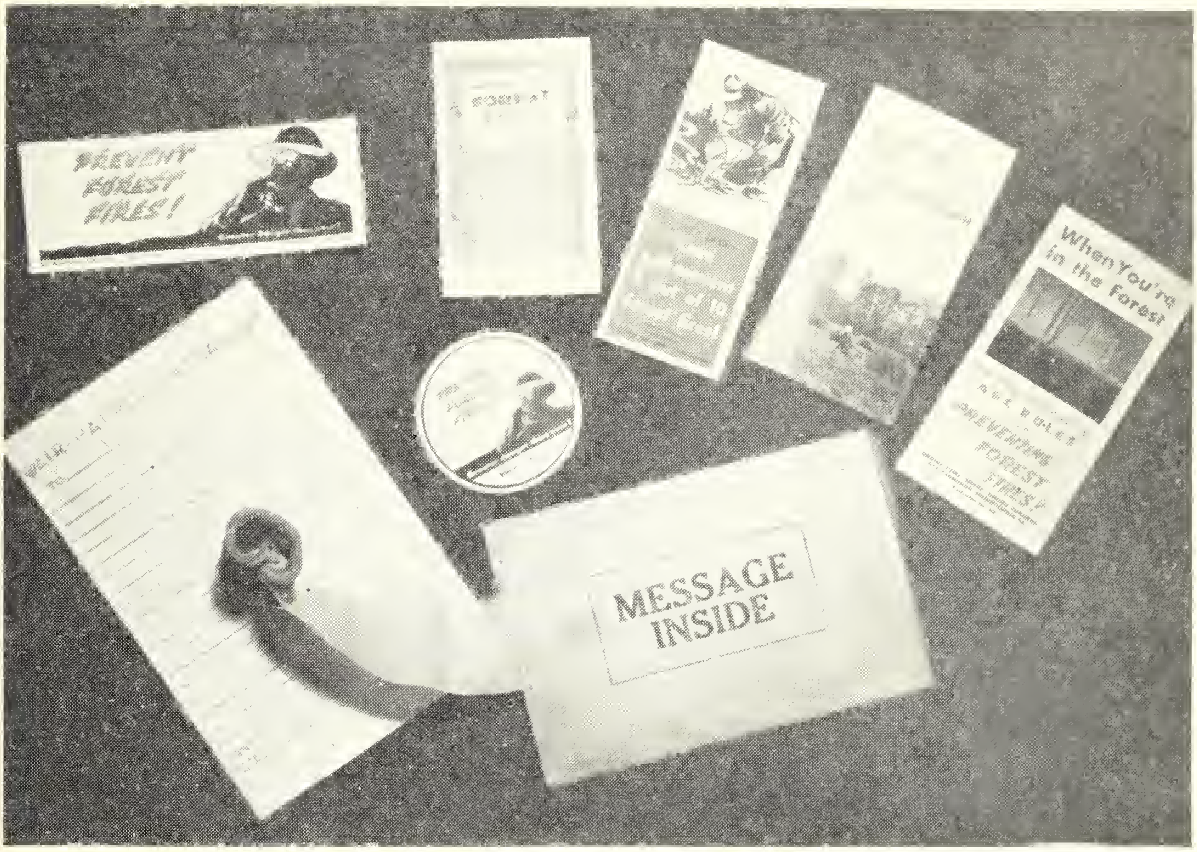
Detection

It is not anticipated that air patrol will eliminate the present lookout tower system. However, the air patrol could accurately locate any fire or smoker in those rather large areas between towers that are not covered. Then, by dropping a message to the tower, he would enable the lookout to locate the fire on his map and take the necessary warden action.

Prevention

It was in this phase of fire control that the air patrol was of the greatest value. Instructions were given to drop messages on all people found burning brush prior to 4 p. m. It is difficult to say just how many of these were knowingly burning in disregard of the law or on the assumption that the wardens traveling the roads could not see them. Apparently the majority of the persons on whom messages were dropped were actually ignorant of the law. Of course the novelty of the idea undoubtedly made many people conscious of the law and has caused much conversation among the class of people who are continually being brought into court for violations. It has been excellent advertising and it is felt that those who were caught deliberately breaking the law will refrain from doing so again because of the large number of small yellow planes similar to the patrol planes that are flying from time to time.

The message dropped consisted of a weighted envelope about 5 by 7½ inches containing a message blank asking them to be careful with their fire, giving advice on how to control it if necessary. It also has a prevention leaflet with some of the most important fire laws.



Envelope with streamer used for dropping messages, and the material inclosed.

The envelope has attached to it a long streamer of bright orange crepe paper which makes it very noticeable while it is in the air and easy to find after it lands. These could be dropped near the fire with reasonable accuracy.

Evidence obtained while the plane was in the air led to several convictions. However, the lack of communication between the plane and the organization on the ground makes evidence hard to get because of the time element. To get names and other evidence for conviction the plane would have to return to its base and telephone the location of the fire to a warden, who would then have to drive to the scene of the fire.

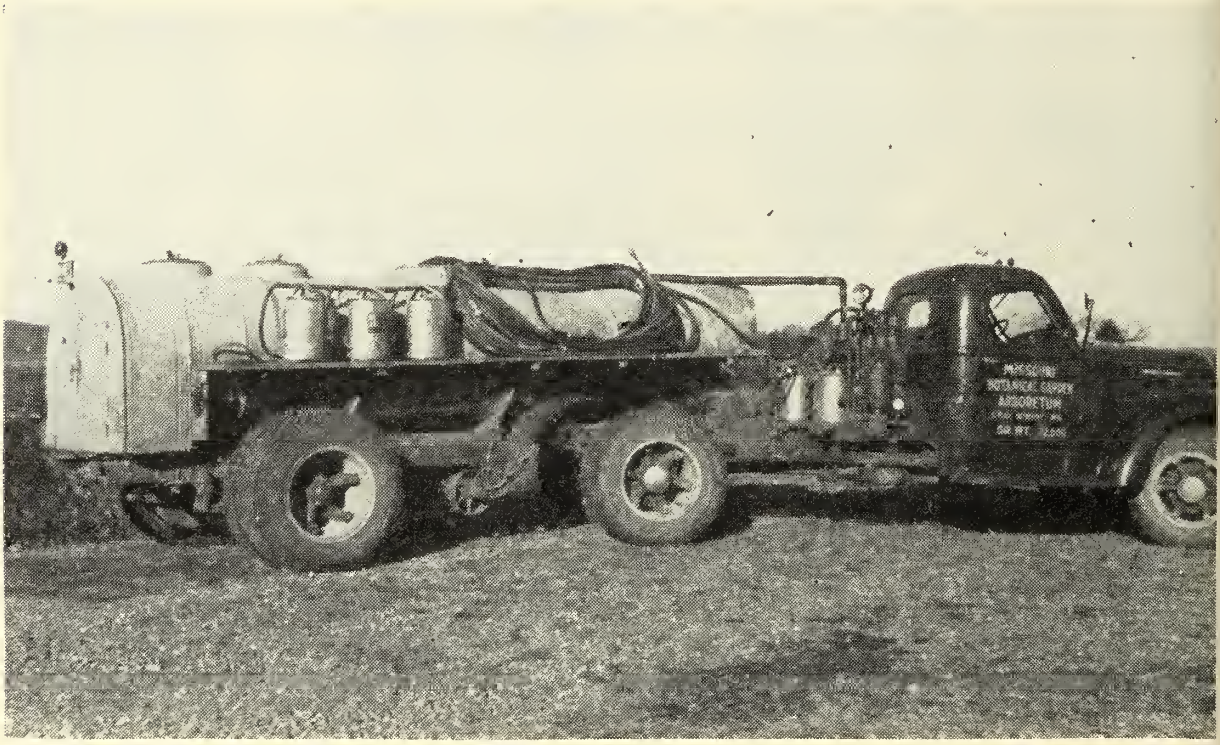
This year it is hoped a better system of communication will be worked out between the plane and the warden organization, whereby quicker action can be taken on both law violations and going fires.

A RURAL FIRE FIGHTING TANKER

August P. Beilmann

Manager, Missouri Botanical Garden Arboretum, Gray Summit, Mo.

The arboretum of the Missouri Botanical Garden is located on the northern edge of the Ozark uplift near Gray Summit in Franklin County. It is not very far from that part of Missouri which "burns" every year. In addition to a tendency of the natives to set fires, there are other possible sources of fire: Two State highways, two county roads, and a railroad. Since the whole arboretum contains only 1,674 acres, it is obvious that fire control work must be good and the detection and dispatching must be as efficient as possible. A cooperative agreement has been worked out with the townspeople under which they furnish some manpower and the arboretum furnishes the equipment. By the terms of the agreement, every woods, field, or building fire within the school district is the concern of this fire department. A telephone system is used for alarm as well as dispatching.



Tanker of the Missouri Botanical Garden Arboretum.

The equipment in use is unconventional and was designed with the thought that water would not be available unless hauled to the fire. To provide water a 1,025-gallon trailer-mounted tank, divided into four compartments, is used. An International DS–40, 161–inch wheel base truck is used as a tractor. This is equipped with low-speed gear and the dual axle is an underdrive rather than an overdrive. Two pumps are mounted behind the cab. One is a Novo diaphragm, powered by its own motor. This pump is capable of draughting water from ponds and cisterns but so far has not been used for that purpose. The other pump, used for fire fighting, is operated from a transmission take-off shaft. It is a 3-cylinder Deming rated at 22 gallons per minute at 400 pounds pressure. Four hundred feet of half-inch high-pressure hose is coiled on the side of the tank. Two adjustable fog guns of the type commonly used for orchards and one solid stream gun as used for high shade trees are always coupled and ready for use. Although used only to a limited extent, the high-pressure fog seems most effective in grass fires, and appears to be equally effective on fires in woodlots and buildings. The tank holds sufficient water to operate two hose lines at maximum pressure for 40 minutes. In addition to this, six back pumps are mounted on the catwalks.

This represents a cooperative effort to develop rural fire fighting equipment in the more thickly populated sections where water is generally not available and where the usual high-capacity pumps of the metropolitan area are at a disadvantage.

Effectiveness of Aerial Detection.—In the July 1946 issue of FIRE CONTROL NOTES, William G. Morris discussed results of studies being made of the effectiveness of aerial detection. This article has attracted the attention of fire men interested in possibilities of replacing fixed lookouts by aerial control. Morris' reply to an inquiry on the part of Mr. E. W. Loveridge of the Forest Service sums up some of these questions and may be of general interest. In the article in question Morris reported that only 7 of 14 test smokes were detected from the airplane used in the test. Mr. Loveridge wanted to know whether or not adjacent fixed lookouts would have discovered a higher percentage. The following is quoted from Mr. Morris' comments:

"The lookout which normally covers the drainage in which we set the 14 test smokes at various points unknown to the airplane observer was not manned.

"The nearest lookout was 8 miles south of the airport where the test smokes were kept going continuously while the plane circled overhead. The lookout at that station knew that test smokes were being set on the airport field and he was watching for them. He reported that he could not see the smoke until the end of the test when he used binoculars to watch the plane land. This lookout was beyond the range of visibility for the small test smokes that were used as shown by visibility measurements with a Byram haze meter from the airport. The observations of the airplane observer when at an elevation of 6,000 feet and a distance of 5 miles also showed that the smoke could not be seen from the south which was the direction of the lookout. At the time of day the tests were made, an observer south of the smoke had the sun at his back. When the aerial observer was on the north side of the smoke looking toward the sun the smoke was easily visible from a distance of 5 miles.

"The fact that the aerial observers should miss 50 percent of the smokes set at points unknown to them cannot fairly be used to discredit the efficiency of airplanes for detecting smokes. The smoke bombs used in these tests were the standard Forest Service type described in the equipment handbook. They emit a rather small column of smoke which has been judged to be equivalent to that produced by an area of about 10 by 20 feet of burning coniferous forest duff. The smoke continues for only 4 minutes. If the smoke bombs are placed on the ground under a high forest canopy the smoke may not rise about the canopy in the short period that it is being produced. A natural fire burning for a longer time will usually build up a column of warm air which will carry the smoke above the treetops. More than one-half of the smokes missed by the aerial observer in the Chelan tests were set in places where the smoke did not rise into the sunlight above the timber.

"One great advantage which the aerial observer will always have over the fixed lookout is that he can view any given point from different directions so as to have the greatest advantage of the direction of the sun and color of the background."

As stated in Morris' final paragraph, it is possible to get any standard of detection desired by means of airplanes but the questions that need more complete answers are the proper techniques to be used for aerial detection and the relative cost of needed service in a given area by the two methods. As fast as these things can be determined, the choice or combination of methods to be used will no longer be theoretical.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

FOREST FIRES AND SEA BREEZES

G. L. Hayes

Forester, Southeastern Forest Experiment Station, Asheville, N. C.

Spot fires which started upwind from going forest fires have been reported by I. S. Stivers, Forest Ranger for the New York Conservation Department, whose district covers eastern Long Island. They had been observed on a number of occasions, and from a number of different fires.

Suspecting at first that incendiaries were setting fires behind him, Stivers sent patrols upwind from going fires. The patrols found no incendiaries but they did find new fires starting. They, and he, also observed that the smoke column, after rising high in the air, turned and moved back in a direction opposite to the surface winds. The spots were starting from embers which fell from this smoke column.

On other occasions, Stivers wrote, surface winds changed abruptly in midafternoon from a northerly or westerly to a southerly or easterly direction, carrying going fires in an unexpected direction and upsetting suppression plans. A typical case was a fire on Sunday, April 1, 1945, at 2:30 p. m. that started with a northwest wind and began to spread to the southeast. Fifteen minutes later the wind shifted fast to the southwest and sent the fire over the Radio Corporation Communications plant at Riverhead.

The conditions described and the location, on Long Island, indicate that the type of local winds known as sea breezes was responsible for both the upwind spot fires and for the rapid changes in direction of the surface wind. Much has been learned about sea breezes in recent years that should be of very material help in planning fire suppression in such coastal areas as Long Island. Obviously, fire suppression is most difficult when rapid and unexpected changes in wind conditions occur. If the wind shifts can be anticipated, defensive action can be planned in advance.

There is an excellent discussion of sea breezes in the June 1946 issue of the bulletin of the American Meteorological Society under the title "Theory and Observation of Land and Sea Breezes," by Raymond Wexler. As many fire control men in coastal areas may not have access to the Bulletin, the following digest of Mr. Wexler's article has been prepared. The land breeze is not mentioned as it occurs mainly at night and is felt primarily over the water.

Definition and Characteristics of Sea Breezes

A sea breeze is a local circulation in which the wind near the surface blows from the water onto the land and returns at a higher elevation from land to water. During the daylight hours the air is heated more over the land than over the water. This sets up a local pressure system that induces the warmer, lighter land air to rise and flow seaward and the colder, heavier air over the water to settle and flow landward.

The sea breezes occur on warm days near the shores of large bodies of water. They are strongest and best developed along the seacoasts but occur also along the shores of bays and large lakes. In the temperate zone the landward flowing wind current may be from 200 to 2,000 feet thick and may reach inland for 20 to 25 miles. Above this is the return current. Under the same conditions it may extend offshore as far as 60 miles over the ocean. In hotter climates or in combination with topographic winds the inland range is extended. The winds from lakes extend shorter distances.

Two distinct types of sea breezes are recognized. The first type develops when there is little or no gradient wind;[1] the second type develops when there is a light offland gradient wind. The first type develops as a small circulation near the shore early in the day, soon after the air over the land has become warmer than the air over the water. With continued heating of the land, the circulation extends progressively farther landward and seaward and grows stronger and deeper. The second type, which is the more common in temperate latitudes, develops over the water and usually comes onto the land suddenly, later in the day. The offland gradient wind holds the colder and heavier sea air back and heaps it up until the force of the wind can no longer hold it. Then the sea air rushes ashore where it is heated until it rises and joins the gradient wind which is blowing out to sea overhead. The typical sea breeze circulation is then established.

The most dangerous part of the sea breeze circulation, from the fire control standpoint, is the front or surface separating the landward blowing sea air from the seaward flowing land air. The reasons are:

1. The winds blow in opposing directions on either side of the front and rise at the front.
2. The front moves. The rate of its advance is less than the velocity of the sea breeze behind it and it decreases as it moves farther inland. When a front moves across a fire, the rear or a flank suddenly becomes the head of the fire.
3. The winds along the front are the strongest and gustiest part of the sea breeze circulation. Initial gusts of the sea breeze as strong as 34 miles per hour have been recorded, whereas the average behind the front is only about 11 miles per hour.

After about a half hour from the time the front has passed, the velocity is usually very constant, with little gustiness. As the higher winds are then flowing opposite to the surface winds, the danger of upwind spot fires is present.

Although the sea breeze blows from water to land, it does not always blow perpendicular to the coast line. It tends to blow perpendicular at first then shift to the right as the day grows older. Thus, along the east coast where the shore is directly north and south it would tend to start as an easterly wind, shifting to southerly. Along the west coast it would tend to start as a westerly wind, shifting to northerly.

---

[1] The gradient wind is the air movement caused by the prevailing pressure differences in the atmosphere. It is the wind that is usually predicted in the Weather Bureau forecasts.

External Factors Influencing Sea Breezes

Several conditions affect sea breeze formation and behavior.

1. *Character of day.*—As sea breezes occur only when the air over the land becomes warmer than over the sea, clear, hot days are most favorable to their formation. They can and do occur on overcast days but they form later, are milder, and extend inland for shorter distances. In general, the clearer and hotter the day, the earlier the sea breeze will form, the stronger it will get, and the farther inland it will penetrate. With light gradient winds and clear skies, it usually starts about 2 to 3 hours after sunrise and ends within 2 hours before sunset.

2. *Gradient wind.*—Calm conditions, or a light offland gradient wind are favorable for sea breeze formation. If the gradient wind is blowing parallel to the shore or off the water, the sea breeze will not develop.

The velocity of the offland gradient wind affects the time of arrival of the sea breeze and the distance inland that it will move. Under calm conditions, the sea breeze may develop near the shore soon after sunup and move progressively farther inland until the maximum temperature for the day is reached, after which is subsides. The stronger the offland gradient wind, the later in the day the sea breeze comes ashore, and it may never penetrate far inland. In fact, if the wind is strong enough, the sea air cannot leave the water. At Danzig a gradient wind of 22 miles per hour was observed just to balance the force of the sea breeze. The front moved intermittently back and forth across the shore line.

To have a front stall over a fire would create a very bad situation. The winds could be strong, and would certainly be gusty and fluctuate wildly in direction, as the front moved back and forth.

3. *Topography.*—Where there are mountains along a shore line, the sea breeze may combine with an upvalley or upslope wind. Such a combination wind is stronger than a straight sea breeze and may extend much farther inland. If the mountains lay several miles back from the coast, separate circulations may be set up in the morning which will merge after noon. Such a combination in California is reported to establish a continuous flow of wind for as much as 40 miles inland. A similar but less extensive flow takes place between Great Salt Lake and the Wasatch Mountains in Utah.

Along the shores of a bay there may be two components of the sea breeze, one from the bay and the second from the sea beyond. The bay circulation will usually be the first to affect the land but may be replaced later by the ocean breeze, accompanied by a change in wind direction.

4. *Vegetation.*—A heavy vegetative cover retards heating of the land surface. Hence, the sea breeze starts earlier and becomes stronger along desert or semidesert coasts than along heavily forested ones. Likewise, with other things equal, conditions along our coast are more favorable to sea breezes when the vegetation is dead and the leaves are off the deciduous trees than after the fields and woods "green up."

5. *Atmospheric stability.*—An unstable lower atmosphere is more favorable for sea breezes than a stable one. In an unsaturated atmosphere, stability depends on the rate of temperature drop with

icreasing elevation. If the temperature decreases more than 5½° F. 1,000 feet of elevation (or 1° F. in 182 feet), the air is unstable and scending convection currents develop easily. If it decreases less than his, it is stable and convectional movement cannot take place. Air ver the land that is very stable in the morning may, through surface eating, become unstable later in the day, hence the hottest part of ne day is most favorable for sea breezes.

6. *Distance from the shore.*—The sea breeze is felt first and has reatest velocity right at the shore. As distance from shore is increased the sea breeze arrives later in the day, has less velocity, and ne front moves more slowly.

With so many factors affecting the time of arrival and characteristics f the sea breeze, it is impossible to set up definite rules which will ell when it may arrive or how it will behave for any particular place r day. Where the sea breeze is observed to have important effects n fires, fire control men would profit by observing its characteristics s related to the factors already discussed. Or the local weather forecaster of the U. S. Weather Bureau might be induced to predict the ime of arrival, its range inland, and probable velocity at and behind he front.

Revision of Fire Equipment Handbook and Master Specification File.—The ire Control Equipment Handbook and Master Specification File were compiled in ne winter of 1936–37 by a four-man committee at the Forest Service Supply Depot Oakland, Calif. The specifications became available as fast as they were comleted, but the handbook could not be printed and distributed until the spring of 939. Although the foreword to the handbook provided for periodic revision of oth the handbook and the specification file, they became badly out-of-date.

In January–February 1945, the National Fire Control Equipment Committee et and, among other things, designated a three-man subcommittee for revision vork. This resulted in a completely revised handbook which was distributed durng November and December 1946. A two-man committee was assigned Novemer 1, 1946, for revision of the specification file. These men conferred with fire ontrol and procurement officers at several regional headquarters and with cerain manufacturers. They made notes of suggestions for specification revisions, nd arranged for data to be sent to the Washington Office for use on this project.

In outlining its work, the committee set up certain objectives with a view to implifying the specification file and making it of maximum value to handbook sers:

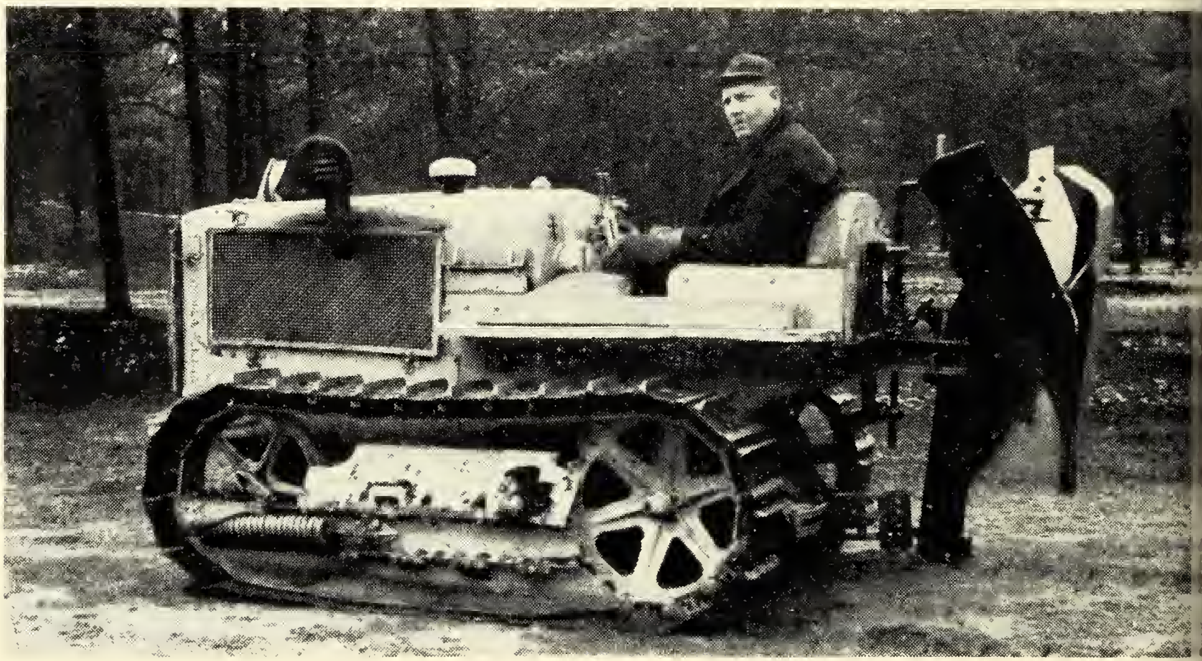
1. To eliminate from the file any specification not used, or not likely to be used, n more than one region.
2. To include the full specification, or a reference to an adequate Federal pecification, in the handbook description of the item involved.
3. To make all specifications in the file as simple as possible, following a pracicable uniform outline.

While further revisions of the handbook cannot be made immediately, the ommittee is making full notes for revisions required by elimination of or changes n the specifications. These data will be available when amended handbook pages re being prepared, which will probably be in the winter of 1947–48. In the neantime the revised specifications are being made ready for requisition, as provided in the handbook foreword.—*Division of Fire Control, Washington Office, J. S. Forest Service.*

THE AAMODT STUBBY PLOW

E. E. Aamodt
Engineer, U. S. Forest Service

The U. S. Forest Service, in cooperation with the Michigan Co servation Department, has designed a low-cost, double-bottom fire li plow which weighs approximately 255 pounds. The beam and coult are in one piece, 36 by 18 by ⅜ inches and made of mild steel plat McCormick Deering plow bottoms, from 12 to 16 inches, can used interchangeably, thereby adapting the plow unit to any si tractor. Oliver bottoms or other types of plow bottoms that can purchased in matched pairs (left and right) will also serve the purpos Another feature of the plow is that the hitch and depth control a rangement is designed so that the unit may be used with any type height of tractor drawbar and will also provide adjustment for plow ing depth and proper draft.



Plow hitched to tractor and in raised position for transporting.

By mounting a simple hand-operated winch or gear box type hoi on rear of tractor, the plow can be raised or lowered from the drive seat and readily transported.

The light weight of the plow requires a tractor of only a com paratively small horsepower drawbar pull and, from tests made various cover types and soil conditions in the Lake States area, h demonstrated its ability to plow a clean fire line furrow.

Fire line furrow plowed in light sandy soil.

The small size and light weight of the plow also permits easy loading
d transporting in a pick-up, passenger car-trunk, or on a small
iler.

The Stubby Plow was demonstrated at the equipment development
eeting held at Roscommon, Mich., last June and created considerable
terest on the part of fire control men.

Chelan Humidity Finder.—Training and inspection trips this season brought
attention the fact that some of our inexperienced Fire Danger Station operators
ere having difficulty in locating the correct humidity ready from the U. S. D. A.
ychrometer Tables after the necessary computation was made. While illustrat-
g how the correct figure could readily be found by using two sheets of paper as
raightedges (one along the air temperature line; the other along the wet-bulb
pression column), it occurred to the author that a simple cardboard device
uld do the job. Thus, the Chelan Humidity Finder was developed. The device
simple to make, easy to operate with one hand, can be left conveniently in the
osed book, and will locate the correct humidity figure quickly.

The finder is made of white cardboard in the shape of a carpenter's square, or
L backward. Its base is 1 inch wide by 5½ inches long, with "Air Temperature"
ttered on it. The vertical arm is 1 inch wide by 7½ inches long and has "De-
ession of Wet-Bulb Thermometer" lettered on it. If desired, the word humidity
n be lettered just under the angle on the Finder with a small arrow pointing
st to the left of the inside corner.

In use, the device is placed on the relative humidity table with the vertical arm
the right side of the proper figure for depression of wet-bulb thermometer, and
e base just under the predetermined air temperature. The figure in the angle
tween the base and vertical arm is the relative humidity. For example: If
e depression of the wet-bulb thermometer (Relative humidity table IX, pressure
.0 inches) is 9.5, and the air temperature is 69° F., the relative humidity is 59
rcent.—Simeon A. Beeson, *Fire Control Assistant, Chelan Ranger District,
helan National Forest, U. S. Forest Service.*

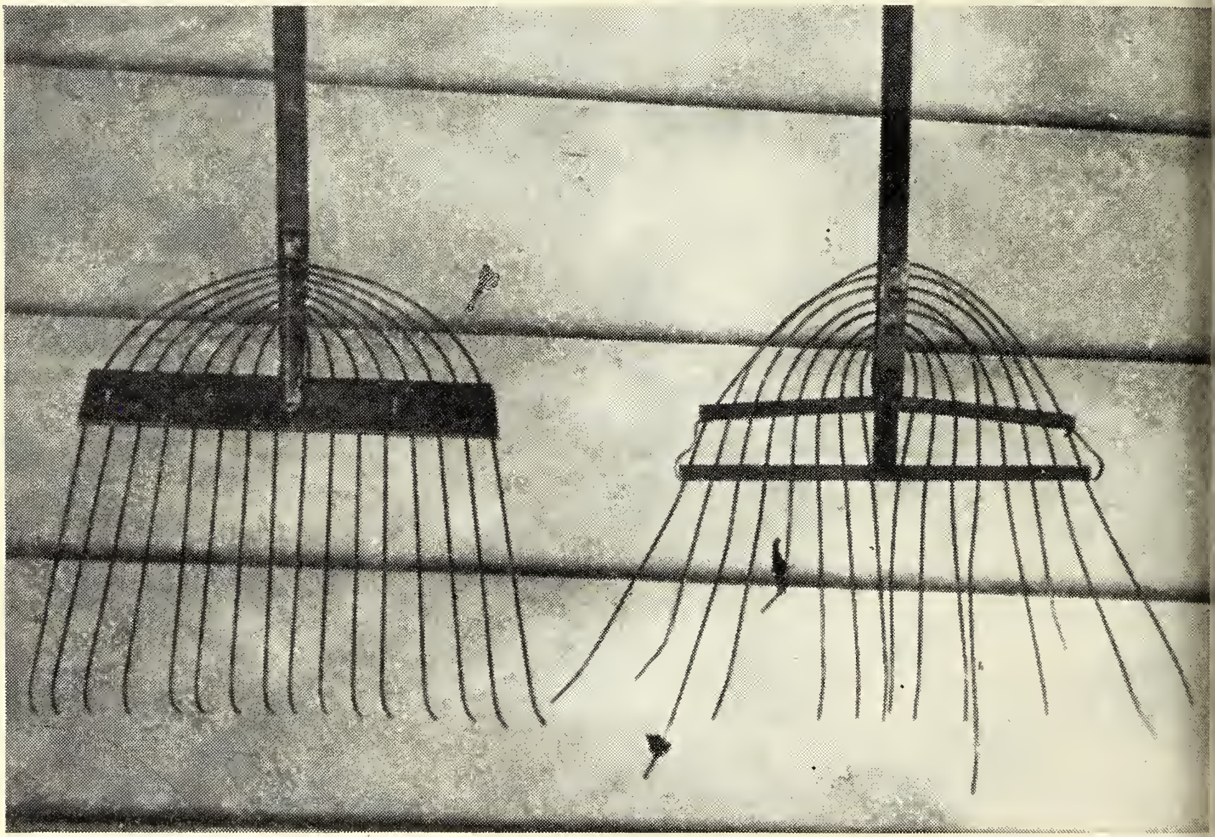
AN IMPROVED BROOM-RAKE FOR LINE CONSTRUCTION

PAUL F. GRAVES

District Ranger, Shawnee National Forest, U. S. Forest Service

An article by Perle Lewis in the July 1946 issue of Fire Control Notes discussed advantages and defects of the broom-rake over other rakes for fire line construction.

An improved broom-rake was put into use on the Shawnee National Forest in September 1946. Its use to date has not been extensive in actual line construction, but it has been given severe field tests in various fuel types. The defects in the old style broom appear to have been corrected without loss of any of the advantages. The replaceable handle is now tapered fitting into a steel ferrule welded to a heavier crosspiece. This has greatly strengthened the handle attachment to the rake without adding seriously to the weight. Notches and clips on the crosspiece prevent the tines from slipping, which was a major defect of the old style.



Broom-rake: Improved (left); old style (right). Condition of old style rake caused by slipping of tines and weak construction.

The broom-rake is very fast and effective in leaf fuels, but it cannot be used to advantage in sedge and heavy grasses, vines, or briers. Heat of fire and hot ashes removes temper from rake tines and in time ruins the rake.

LIGHT TRACTOR-TANKER *vs.* ¾-TON WEAPONS CARRIER TANKER (FIRE SUPPRESSION WITH HIGH PRESSURE FOG)

J. W. West

Assistant Supervisor, Wasatch National Forest

J. W. Mattsson

Forester, Division of Fire Control, Intermountain Region

Such flash fuels as cheatgrass and sagebrush have increased so rapidly in many areas of Region 4 during recent years that a highly mobile light tanker is one of the Region's chief needs. Fire suppression men have sought a tanker that would meet the following requirements:

1. Be able to leave the road and go into inaccessible country on its power;
2. Be maneuverable under topographic and cover conditions where fires occur;
3. Be rugged enough to stand up under tough demands; and
4. Be readily accessible for holding a fire line or participating in initial attack before ground crews can be dispatched.

To meet this need, a tractor-tanker has been in use on the Wasatch National Forest since 1945. Early in 1946 a weapons carrier (¾ ton, 4 x 4) was converted to a tanker truck and assigned to the Wasatch Forest. This assignment made possible comparison of two kinds of equipment with approximately the same water carrying capacity under similar terrain and operating conditions.

The tractor-tanker, described on pages 41–44 of July 1946, Fire Control Notes, was equipped with two 53-gallon water tanks—mounted one over each track of the crawler type tractor. Other equipment included a Bean Royal 10 high-pressure pump, 200 feet of ¾-inch high-pressure hose, and a Bean No. 685 master fog gun. The weapons carrier was converted by installing a 100-gallon tank, a 200 F demountable Bean pump, 150 feet of high-pressure hose, and a Bean master fog nozzle.

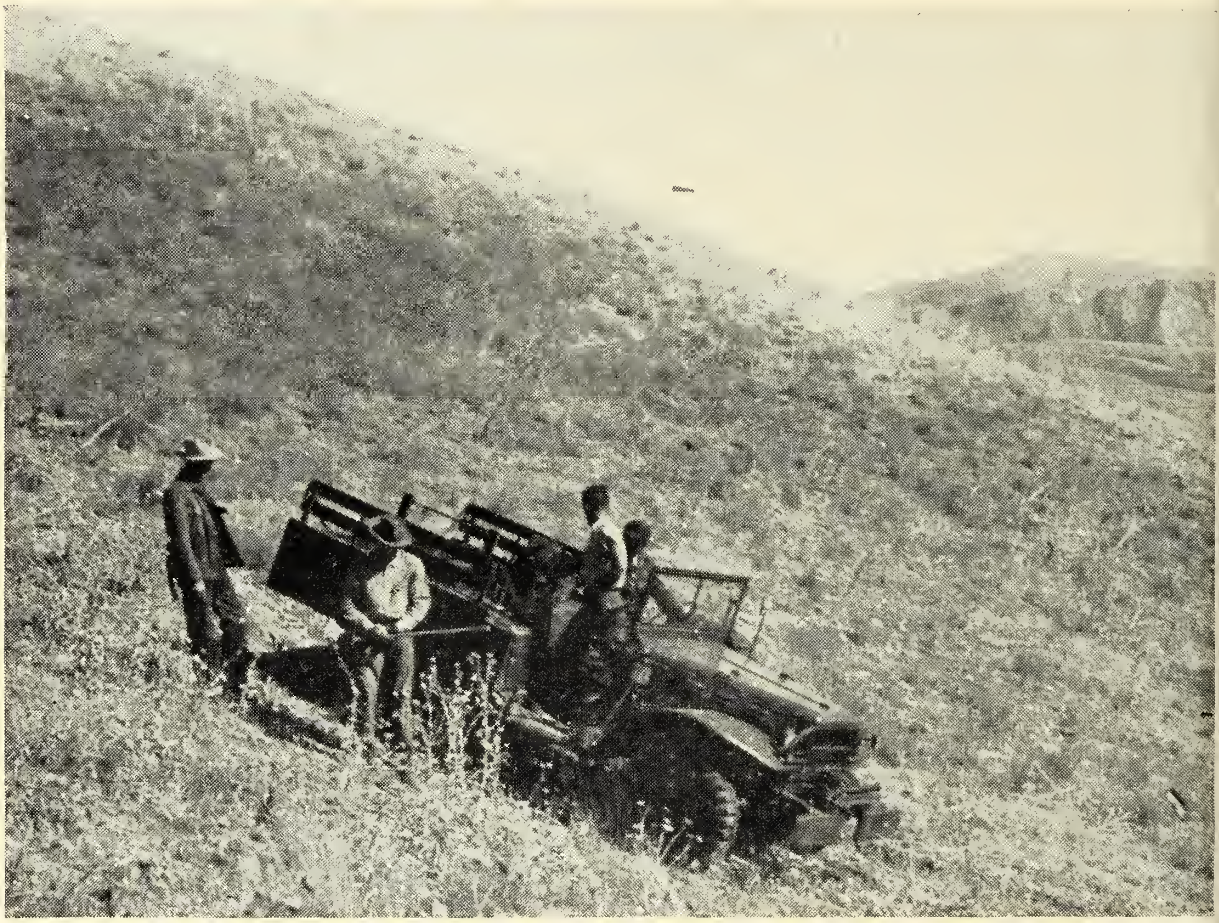
Tests provided the following general observations concerning the operation of these two pieces of equipment:

1. The tractor-tanker is slow in getting to fires when compared to the ¾-ton weapons carrier, mainly because of the tractor-tanker's slow speed of from 3 to 7 miles per hour on its own power. About 15 minutes is also lost in loading and unloading the tractor from the carrier truck. (This 15 minutes is consumed in blocking and unblocking the tractor, chaining it down securely, warming up motor, and getting on and off the truck.) Futhermore, the tractor makes an unbalanced, top-heavy load on the 1½-ton truck, requiring slow and careful driving. To maintain safety, personnel of the Wasatch have to be extremely cautious. The truck travels almost entirely on improved roads on level terrain.

The weapons carrier, however, can travel faster on improved roads than the 1½-ton carrier truck. When it leaves the road, the carrier can travel almost any terrain the tractor can negotiate, and at a much greater speed. The weapons carrier reaches the actual fire line in much less elapsed time than the tractor, a factor of prime importance in suppressing flash fuel fires.

2. The tractor-tanker ties up two pieces of equipment, itself and the transporting truck. Generally during the fire season the tractor-tanker is kept loaded for quick getaway and thus is unavailable for other uses unless the tanker is unloaded in emergencies.

3. The tractor cannot be used for other project work because it is not equipped with bulldozer and has insufficient power. With a slip-on unit, the weapons carrier can be used for project work during periods of favorable weather. In 1946 the weapons carrier was used a total of 3,000 miles, with about 1,200 charged to fire suppression, while the tractor-tanker has been used only on suppression.



Three-quarter ton weapons carrier on 47 percent headslope. It stalled at same point going ahead as in reverse.

4. The tractor-tanker is not well-balanced; when climbing it carries all the weight on the rear ¼ of the tracks. The maximum head slope, or point at which tractor stalls, is approximately 37 percent without pump operating and 30 percent with pump operating. The weapons carrier stalls at approximately 47 percent.

A side slope of 40 percent seems to be the maximum that the tractor can maneuver. If rocks or other obstructions are encountered, especially by the upper track, the tractor tips easily. On slopes of the same type, the weapons carrier tends to slide rather than tip. This is an advantage because the carrier will slide around obstructions rather than climb them and increase the risk of tipping.

5. The tank capacity of the tractor-tanker is limited to two tanks holding 53 gallons each. This is not enough considering the cost of equipment, manpower tied up, and extremely slow time in getting

back to a source of water supply. The weapons carrier can quickly get to a source of water and return. If necessary, its water supply can be increased to 150 gallons. Since the pump and tank is a demountable unit, it could be taken off at a stream or source of water if close to the fire and used like a marine pump. The weapons carrier is then free for other use on the fire.

6. The tractor-tanker unit costs about twice as much as the converted weapons carrier, and its operating cost is much higher.

Region 4 now recommends use of the four-wheel-drive weapons carrier with slip-on pump and tank unit rather than the tractor-tanker. For work in flash fuel fire suppression, the carrier is more efficient and a vast improvement in mobility and general usefulness. Although the tractor-tanker is a good machine, and in 1945 appeared to be the best rough terrain water carrying equipment available the weapons carrier meets the requirements of a mobile light tanker in a much better fashion.

Water Conserving Studies

Since the tank capacity on both the tractor-tanker and weapons carrier is limited, experiments were made with various nozzle openings and pressures to find ways of conserving water. Our work was partially simulated by the article in Fire Protection Notes of August 1946, Vol. III, No. 8, Western Fire Equipment Co. This article opens up the question: Why use high pressures on some types of fuels when lower pressure could conserve water? Table 1 gives the relation between disk size and gallons per minute discharged at various pressures with the Model 685 Bean master fog gun, used on both the weapons carrier and tractor-tanker.

TABLE 1.—*Water discharged by Model 685 Bean master fog gun, at specified pressures and disk sizes*

Disk No.[1]	Rate of Discharge,[2] at—		
	400 pounds	600 pounds	800 pounds
	Gallons per minute	*Gallons per minute*	*Gallons per minute*
3	1.0	1.2	1.4
5	2.4	2.9	3.4
6	3.4	4.2	4.9
7	4.6	5.7	6.7
8	6.0	7.4	8.5
10	9.2	11.4	13.0
12	13.9	17.0	19.9
14	21.1	25.8	29.9
16	31.7	39.0	44.5
18	34.0	41.6	47.9

[1] Disk numbers represent 1/64ths of an inch—that is a No. 3 disk has a hole ¾ inch in diameter, etc.

[2] Discharge capacities of gun are for adjustment in straight or full stream position wide open. Usual long fog position gives about 20 percent less capacity.

It is evident from table 1 that if we can fight fire successfully with a lower pressure and a smaller disk, the water supply will last considerably longer. For example, with 400 pounds pressure and a No. 6 disk, the water supply will last twice as long as with 600 pounds pressure and a No. 8 disk: 31 minutes compared with 14 minutes, for the 106 gallons of water available on the tractor-tanker. This extra water supply may be just what is needed. If actual tests show that good streams of water are furnished and a satisfactory suppression job done with a properly designed small tip, then the water supply can be conserved and the efficiency of the unit increased considerably. After a limited number of tests with different pressures and nozzle openings on different fuel types, the region formulated the following general ideas:

1. At high pressures, 600 pounds and above, the strain on hose, couplings, valves, and other fittings is near the critical point. Maintenance costs are high, the chances of a break-down on a fire are great, and on-the-ground repairs are generally impossible.

2. Basic training of nozzlemen should include thorough instruction on the effect of different pressures at different nozzle openings. Nozzlemen generally accept pressure at which pump is already set and use the same pressure and disk throughout the suppression job. Most of the pressure guns are now equipped with quickly interchangeable disks, and it takes less than a minute to change disks. By using the right disk for the fuel type, the nozzlemen have an effective medium for conserving water even without changing pressure. As fuel types change definitely and the cover is not too mixed, the nozzleman can change disks as frequently as he needs to in order to get the most out of the limited water supply available.

3. For light fuels such as cheatgrass and with an $\frac{8}{64}$th-inch disk, 200 to 300 pounds pressure is generally adequate. Tests with smaller disks indicated that there is not a sufficient margin of safety on cheatgrass type with only 200 to 300 pound pressure.

4. For heavy fuels, such as sagebrush and oak, 400 pounds pressure and an $\frac{8}{64}$th-inch disk did the job safely with the least expenditure of water. With still heavier cover type such as thick oak it might be necessary to increase the size of disk or pressure in order to get the stream of water to the source of fuel. Pressure of 200 pounds and a No. 6 or No. 8 disk appeared inadequate for a hot fire, where rate of spread might be faster than rate of suppression.

5. For the tests conducted in sagebrush, cheatgrass, and oak brush, which may not be conclusive, there seems to be no material advantage in using 600 pounds pressure over 400 pounds pressure.

6. Another important consideration, besides the saving of water in using lower pressures, is the increased efficiency of the nozzleman. At lower pressure he can handle the hose and pressure gun with less strain, direct his stream of water more advantageously, and—if he does misdirect it—wastes less water.

7. A semifog, in the tests conducted, was more effective in extinguishing the sagebrush and cheatgrass fires than a full stream or complete fog. A full stream puts too much water in one place on one small area; a full fog cooled down the outer extremities of the fuel but did not reach down into the heavier fuel underneath, which would immediately blaze up after being left a few seconds. Semifog not only cooled down outer edges, but had mechanical force enough to penetrate into the piles of fuel and duff. Semifog also has an advantage over full fog in that the operator does not have to get as close to the fire in order to direct an effective stream of water on it.

Much more study needs to be given to the effect of pressures and disk openings in relation to fuel types. Our preliminary tests are indicative only; a more detailed study could also be of value in determining the most efficient pressures at various nozzle openings.

Parachuting Heavy, Odd-Shaped Objects.—An irrigation company renewing a dam in remote country on the Bitterroot National Forest hired the Johnson Flying Service to drop some heavy iron parts of the headgate at the dam site. Region 1 furnished parachutes and technical advice and obtained the details of operation given in table 1. The heavy, odd-shaped pieces were dropped from an altitude of approximately 300 feet while the plane traveled at nearly 100 miles per hour. Spotting was good, except that a longer lead should have been given the heavier objects. All landings appeared easy.

It is concluded that heavy, odd-shaped objects can be successfully dropped from a plane by using one or more chutes and discharging the package so it does not roll.—James V. Waite, *Foreman of Parachute Squads, Northern Region, U. S. Forest Service.*

Table 1.—*Object dropped and parachute operation*

Object	Dimension	Weight	Discharge	Parachute operation			
				28-foot chutes	Attachment to object	Estimated distance for canopy to inflate	Estimated rate of descent
		Pounds				*Feet*	*Feet per second*
Gate stopper	3′ 3″ x 3′ 3″ x 7″	585	On edge from greased slide by 3 men. Did not tip or turn over.	[1] 2	At 1 point at rear	[2] 140	[3] 20
Gate frame	3′ 10″ x 3′ 7″ x 4½″	425	On edge from slide by 3 men. Did not tip or turn over.	[1] 2	At 2 points 2½ feet apart at rear of frame. Cargo chute webbing fastened around frame.	[2] 120	[3] 19
Threaded bar	9′ 4″ x 3½″ diameter	250	From door by 1 man	1	Chute webbing on threaded end one-third distance from end so bar would land at an angle with threaded end up to avoid damage to threads. ½-inch rope wrapped around webbing and bar to prevent slipping.	100	17
Angle irons	7′ x 6″ x 6″	150	do	1	At end of irons. Two strand No. 8 wire passed through holes in irons and wrapped with canvas. Chute webbing passed through wire loop.	85	16
Cylinder stand, hollow	Bottom, 2′ 5″ x 12″ diameter; top, 2′ 5″ x 9″ diameter.	100	do	1	½-inch ropes, padded to prevent shearing, passed through holes in top formed 3 loops to which webbing was secured.	85	16

[1] 2 static lines used.

[2] Required slightly longer to open because of weight of object.

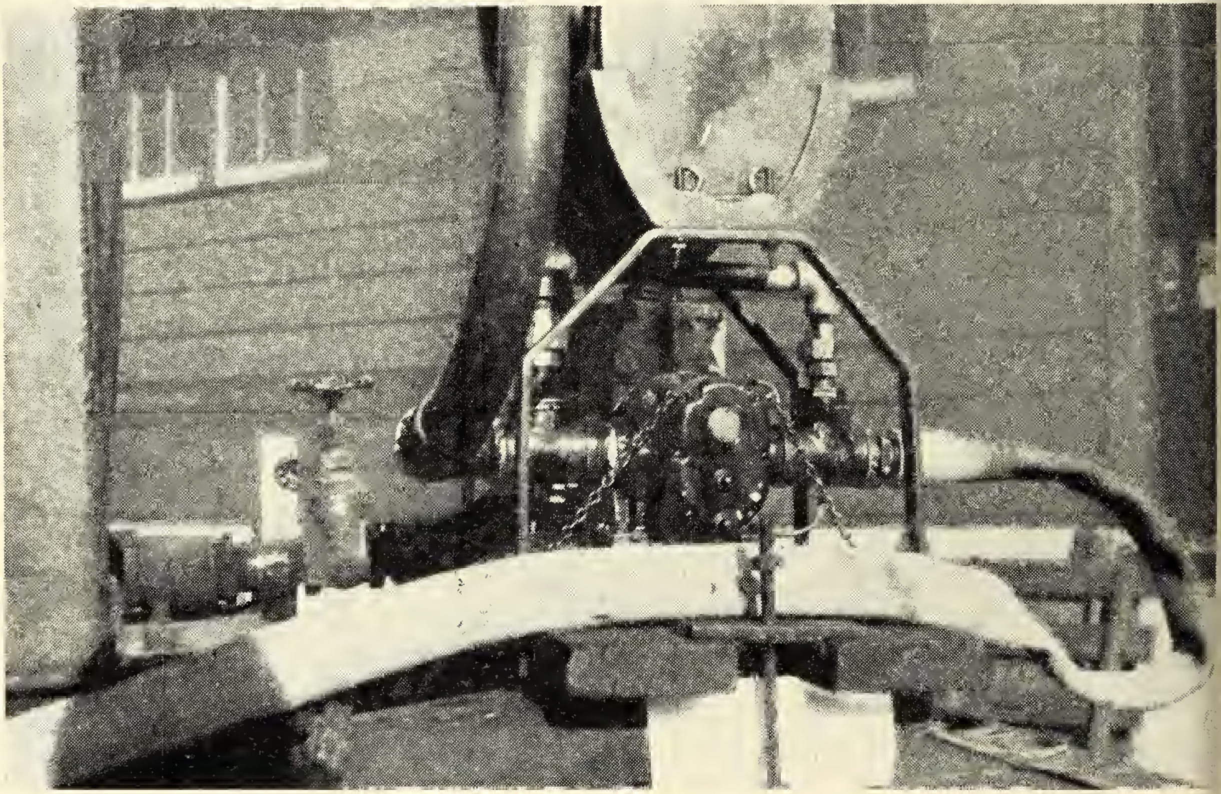
[3] Slightly more rapid than normal.

SHASTA COFFIN TANKS AND TRAILER

M. O. Adams

Central Dispatcher, Shasta National Forest

Since the beginning of the Forest Service, every man who has combated forest fires has tried to develop new methods of getting water to a fire for suppression and mop-up. Such a problem confronted the firemen on the Shasta National Forest and in order to overcome this, firemen first developed small initial attack tankers that carried a small tank of water under air pressure, which in later years grew to our powered pump units. This answered some of their problems but the need for a larger unit developed, and the large 450-gallon primary tanker was placed in service.

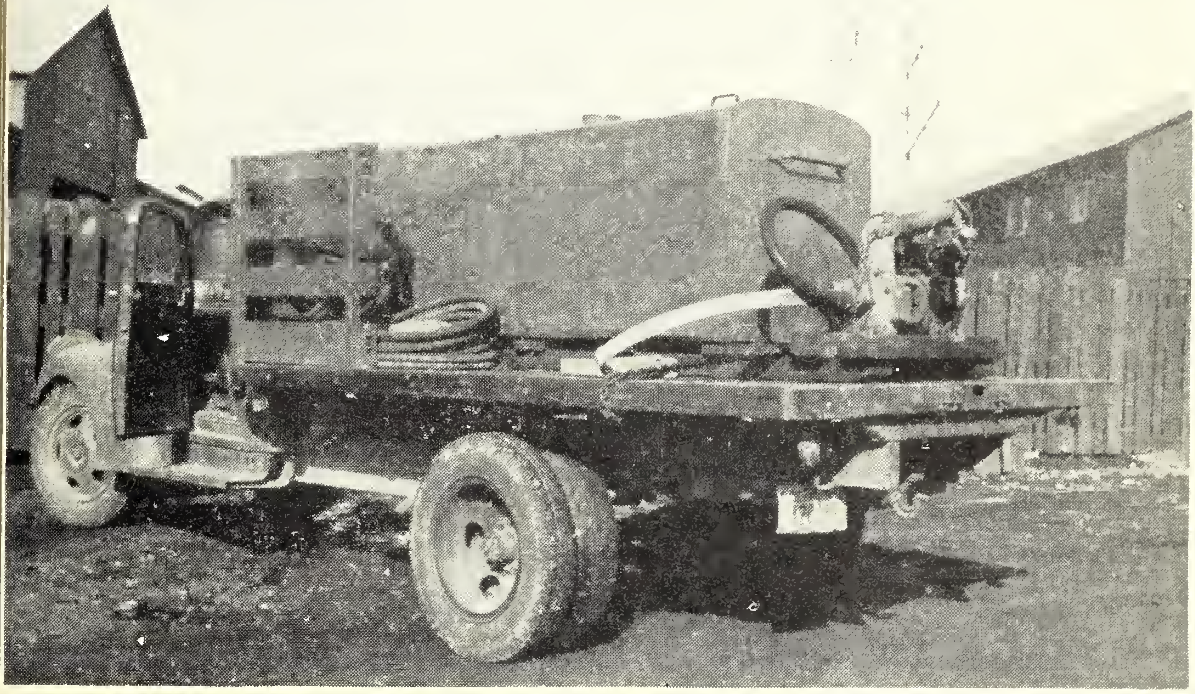


Mounted Pacific Pump showing tie-down bracket and bolt.

As each problem was answered, another developed. We had small initial attack tankers and primary tankers of the larger sizes which, after arriving at a fire that had spread to major proportions in rough terrain, could be used only along roads and in servicing the fire camps. The crew tanker, in many instances, was used to haul water to a certain location on the fire and from there it was packed in back pumps to the fire line. The cost of operation of the unit was high and because of this, separate water supply units and tank trailers have been developed on the forest.

Ranger Oscar Barnum of the Pit District developed the idea of a slip-on supply unit. During the winter of 1937 he obtained a large tank from a logging operator who had used it for sprinkling logging roads. This tank was mounted on skids. Ranger Barnum then connected a Bingham portable pump to the tank. The completed unit was mounted on a loading platform and whenever the need arose for this unit, a ton and a half stakeside was backed up to the loading platform and the tank unit skidded onto the truck. This tank held approximately 800 gallons of water, and supplied the smaller tankers on a fire. Where a dry camp was established, the tank furnished water for camp needs. During the mop-up stage on a large fire, Ranger Barnum was able to release his initial attack tankers and return those crews to their stations while the large unit remained at the fire with a crew to complete mopping up.

Melvin Barron, former Ranger of the Goosenest District, had also been working on the idea of a large water supply unit that could be used for any type of servicing and for releasing the initial attack tanker on fires that had gone into the mop-up and patrol stage.



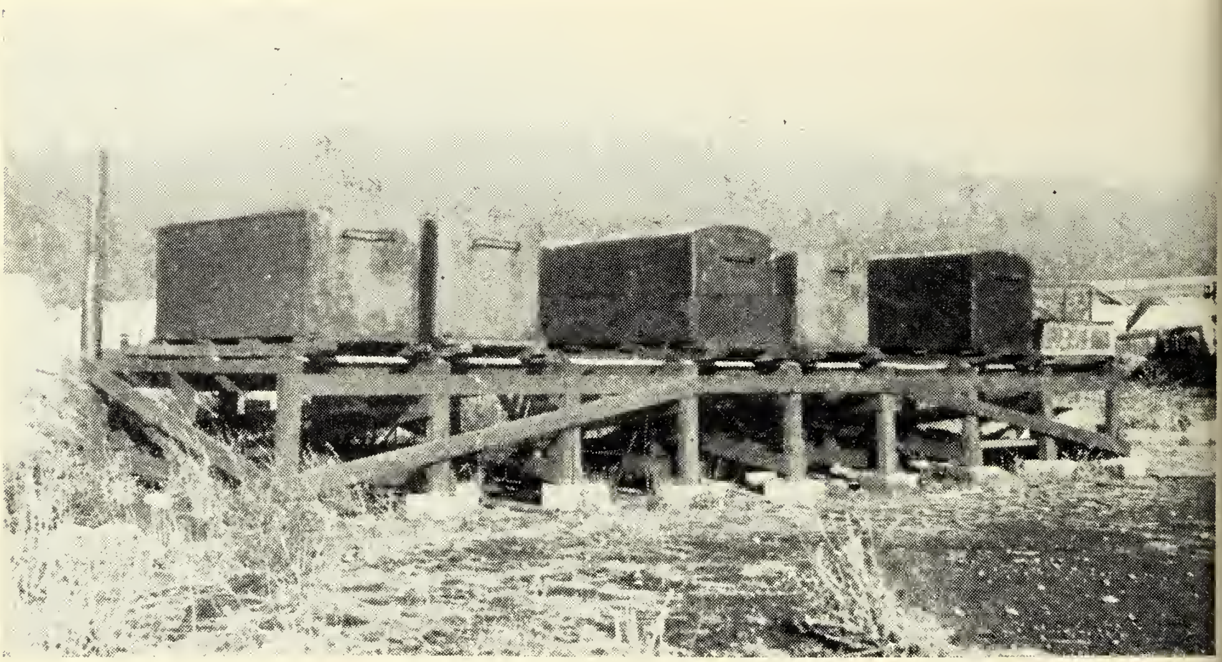
Coffin tank and Berkeley pump.

During the summer of 1938 Ranger Barron drew the design of the present Shasta Coffin Tank and had the Klamath Iron Works at Klamath Falls, Oreg., fabricate a 500-gallon tank at a cost of $60. To give it greater stability and also to prevent surging effects, Barron had two baffles installed. He mounted the completed unit on 8- by 8-inch skids, leaving ample room beyond the rear of the tank for a platform to hold the pump unit. A Pacific portable pump was used for the power unit, and to prevent the necessity of stopping the pump every time the nozzle was shut off, a bypass was built into the pump unit. Because of the shape of the tank, some unknown person tacked the name Coffin Tank to this unit and since that time the name has stuck. Units developed by Rangers Barnum and Barron were so successful that the Shasta Forest purchased two additional tanks during the 1938 fire season and six more in 1939. The power units for these tanks were either the Bingham portable pump or the Pacific type portable pump, both mountable on the pump platform at very short notice.

A better power unit for these tanks was provided when the California Region came out with the Berkeley two-stage centrifugal pump powered by a one-cylinder Wisconsin air-cooled engine, a semiportable type. Firemen were able to instruct an experienced truck driver on the operation of the Berkeley pump in a very short time.

Seven coffin tanks are stored at the Mount Shasta supervisor's headquarters as part of the forest fire warehouse stock. To expedite loading, all the tanks are stored on a special platform with pipe rollers. Whenever a call for a tank is received, a 1½-ton truck is dispatched to the rack where two men roll a tank onto the truck. The truck then returns to the fire warehouse where a pump is mounted, suction lines connected, and the required amount of hose and pumper box is placed on the unit. A chain binder ties the tank to the truck.

If the fire is close to water supply points, the truck is dispatched with an empty tank to be filled near the fire. Should the fire be remote from water, the unit is filled at the supervisor's headquarters with 500 gallons of fresh water and dispatched to the fire.



Tank storage and loading rack.

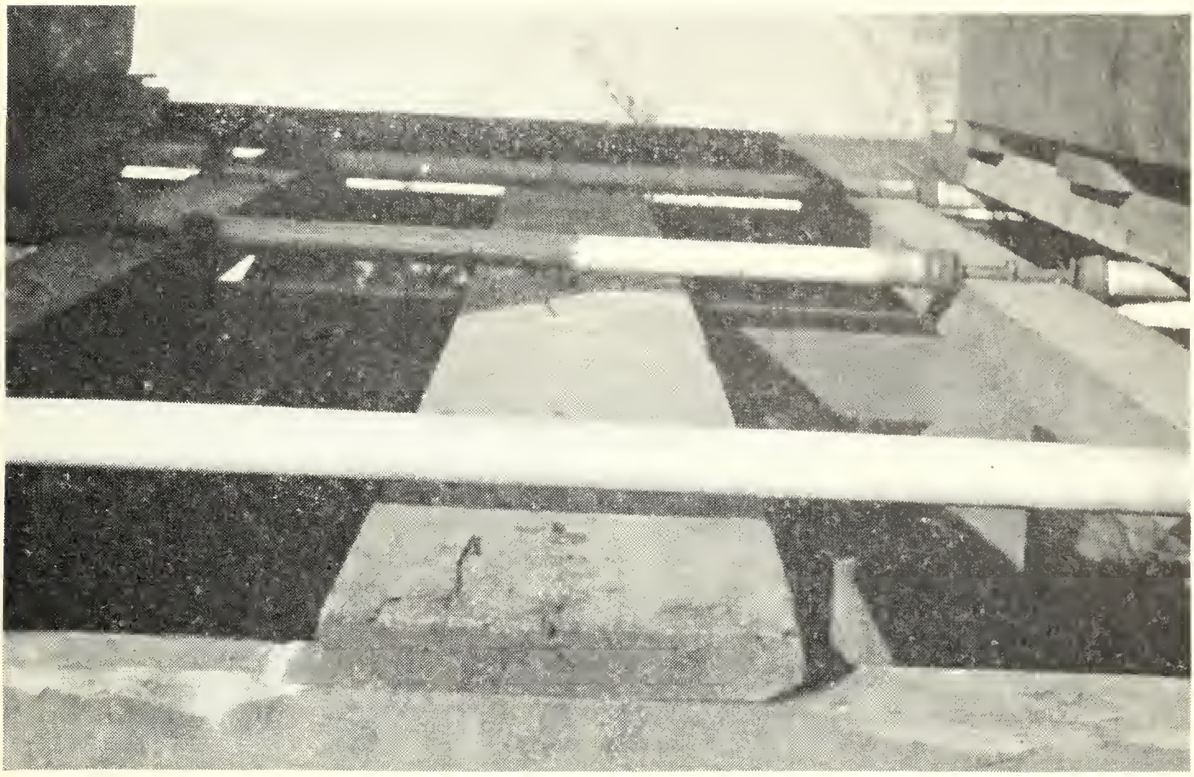
To expedite the mopping up of larger fires during the 1938 and 1939 fire season it was necessary to tow regular tankers and coffin tank units up steep portions of fire lines that had been constructed by bulldozers. In some cases towing damaged trucks and tankers.

George K. Fox, former fire control officer of the Shasta Forest, conceived a unit that could be pulled by either a truck or bulldozer. Incorporating all the features of the coffin tank, it would be a trailer unit which could be pulled to any location on a fire where a bulldozer had constructed a fire line and could be used for the tow unit. In more favorable terrain the tow unit could be a stakeside.

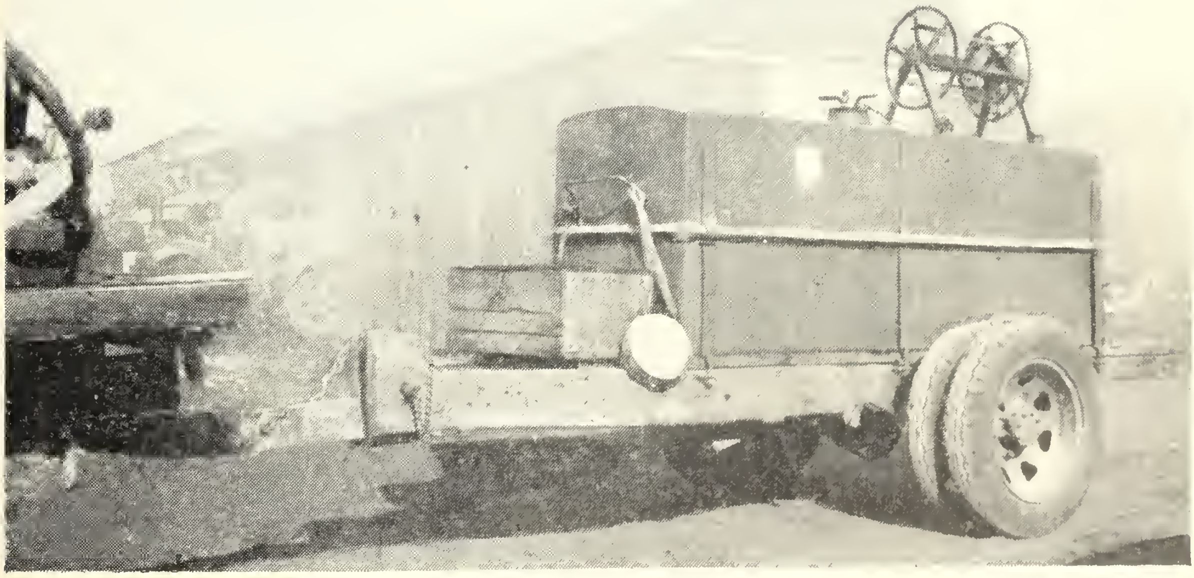
In the winter of 1939 the equipment shop at Redding constructed the Fox trailer unit, using a standard 1½-ton truck rear axle with dual wheels at a cost of $150. Scrap truck-chassis iron was used for the framework and the tongue was constructed of very heavy steel. This tongue was fixed to the trailer chassis by means of a hinged connection.

The tongue rode in an enclosed slot making it possible to lower or raise the tongue for attaching to either a bulldozer or a truck.

The trailer bed was built of 13-ply plywood to which the tank was bolted. Ample room was left on the trailer bed for mounting a Berkeley centrifugal pump. Brackets for holding suction hoses were placed on the top edges of the tank, and at the rear and top of the tank a live hose reel was installed. By placing the live hose reel on the top of the tank, the nozzleman was able to unreel the hose on either side of the trailer unit without any trouble. Mounted forward of the pump unit, the tank acted as a protective shield for the pump. Just forward of



Tank rack showing pipe rollers.



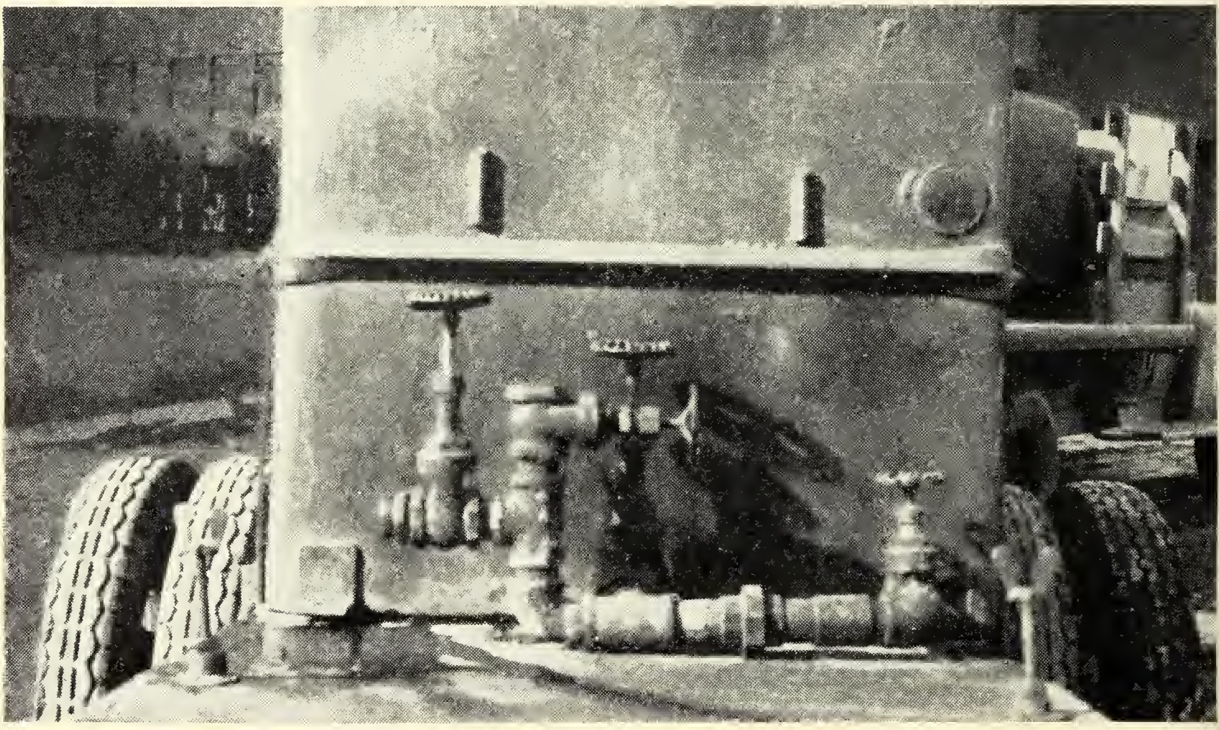
Shasta Coffin Trailer.

the tank is a tool box to hold the necessary connections, spanner wrenches, lubrication oils, strainers, etc.

On the under side of the tongue, forward of the tongue slot, a special jack slot was constructed so that a hydraulic jack could be inserted to lower or raise the tongue when connecting the trailer to a bulldozer or a truck. This jack could also hold the trailer unit in a loading position when the unit was not in use.

The coffin trailer unit has been used since the 1940 season and as soon as a fire boss sees that he can use a coffin tank or trailer he asks the dispatcher for the proper units. Both the coffin tank and the trailer have become an integral part of the fire-control equipment on the Shasta Forest.

Other forests in northern California have seen the coffin tanks in operation and often request the Shasta Forest to send the desired number of units on stakesides to their fires. The Mendocino, Modoc, and Plumas Forests all used those units in the 1946 season.



Coffin Trailer valve arrangement.

By using these units, forests are able to release their initial attack crews much earlies, and to reduce the time required to mop-up a major fire.

The standard squad tanker now costs 23 cents per mile for every mile traveled; when pumping, the squad tanker costs $6.50 per hour of pump operation. But the coffin tanker costs 12½ cents per mile for the stakeside and $1 per hour for the pump unit.

During the winter months, one of the coffin trailer units is used to haul water to the Forest Service horse pasture.

These units are also used on hazard-reduction work and highway safety strip burning. During highway safety strip burning, four of the tanks are placed on a semi, providing a 2,000-gallon water supply unit. By this means we keep all our units at the burning job rather than having to pull some out to return to water supply points.

In 1942 all of the coffin tanks were treated with a rust preventive so that any of the units could be used for camp water and for furnishing drinking water to any fire, besides serving as tankers on suppression and mop-up.

U. S. GOVERNMENT PRINTING OFFICE: 1947

olume 8 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

NITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1947

Contents

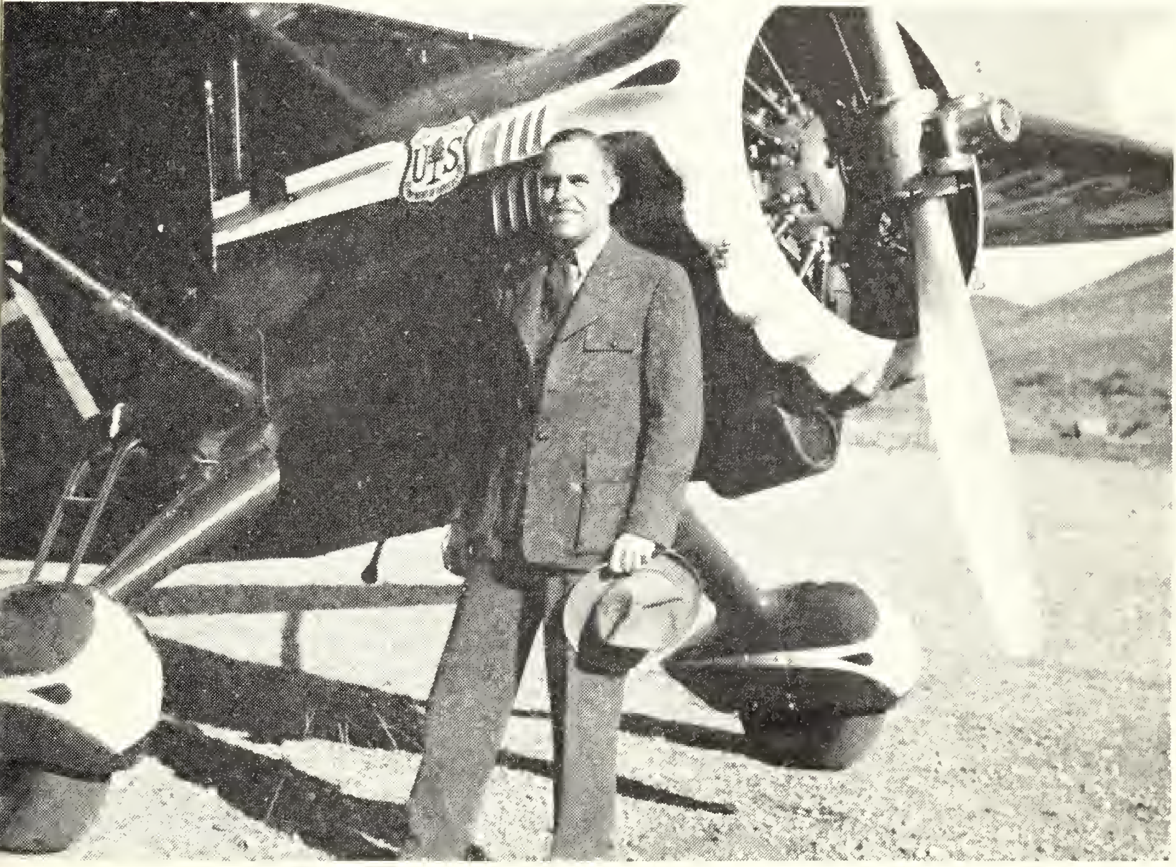
Page
n the passing of Dave Godwin 1
G. A. MacDonald
ogress report on smoke masks and goggles 3
J. M. Walley
he forest fire hazard in the sunspot cycle 4
William M. Morris
smoker fire prevention campaign that paid off 9
Russell W. Bower
dapting the "weasel" to fire control 10
E. A. Grant
common fire control fallacy 13
S. H. Marsh
rest fire statistics: their purpose and use 14
J. A. Mitchell
w and accessory rack for warehouse use 17
Elvin R. Fellows
raining high school boys in fire suppression 18
John D. Whitmore
ir operations handbook: cargo dropping 20
Division of Fire Control, United States Forest Service
ombination tree marking gun and backfiring torch 21
A. C. Wells
og mop-up nozzles 24
A. B. Everts
wo-wheel mess trailer 26
John W. Cooper
ommercial tackers facilitate fire sign posting 27
E. A. Hanson
orest fire fighters service in Indiana 28
Joseph S. DeYoung
og nozzle hook 29
M. E. Sullivan
he Gila smoke jumpers 30
Don Beck
he use of a wetting agent on a forest fire 32
Edward Ritter
odifying the trapper Nelson pack board 33
Bernard Frank
lywood water tank 34
H. C. Buckingham
lash disposal in selective cut ponderosa pine stands 35
Merle S. Lowden

ON THE PASSING OF DAVE GODWIN

G. A. MacDonald

Washington Office, U. S. Forest Service

A few days ago, Art Brown, Chief of Fire Control in the W. O., sked the writer to do "something on Dave Godwin for Fire Control otes."



"The magazine was his baby, you know," said Brown. "Roy Ieadley put him in charge after the Fire Equipment Conference t Spokane in February of '36, when it was decided that a medium as needed for the Nation-wide interchange of ideas and developments n fire control. If "Notes" has been a common meeting ground, a learing house for the creative efforts and observations of fire fighters n all protection agencies and interested organizations, such as it was ntended to be, Dave was mostly responsible."

For a periodical that circulates largely among members of a service nost all of whom knew Dave personally or by sight, and certainly ll of whom knew of his sudden and untimely death in the Blue Ridge Iountains on Friday, the 13th of last June, what remained to be said bout the late and truly lamented Chief of Fire Control and Brown's redecessor?

No doubt, foresters and many others who knew Dave throughout the country experienced the shock which the writer did when, the following Sunday morning, he picked up his Washington newspaper and saw Godwin's photograph on the front page and his name among the air-crash dead. Surely, every Federal forester knew the details of his notably successful career in the Forest Service for those were widely publicized at the time of his appointment to be Chief of Fire Control little more than 6 months before. Surely, most of them read the memorial tribute paid to him as "an outstanding public servant whose record and contributions to the Forest Service and the country were of the highest order," 3 days after his death, by Chief Forester Lyle Watts.

On Monday morning, the writer went straight to Brown's office. Brown had just returned from the scene of the crash where he went to identify Dave's body. As the writer came down the corridor, past foresters' offices, there was a hush over the place; the door of Dave's last earthly office stood open, on the desk was a neat pile of letters, telegrams and memos waiting his return. Brown looked tired and worn. The writer said. "Was he—could you recognize him?" Brown's eyes appeared to retreat into shadow. "Fifteen of the victims were not broken," he said. "He was not among them. It was an experience I hope never to go through again." That was all.

Most everyone knew that only recently Dave Godwin had come back to the neighborhood of beautiful Christ Episcopal Church, Georgetown, and bought a home half a block up the street from this church where he served as a boy. His life had taken him in a wide circle from the time when, in his teens, he ventured west and began his Forest Service career as a guard on the Inyo National Forest in California.

The ability to inspire confidence and liking, the character and integrity that Dave possessed were evidenced by his progress throughout his life. They were strong factors in his rise from forest guard, to ranger, to supervisor on the Mendocino, to fire control planning for the California National Forests. Again, they were evident, in World War I, in which he served 22 months overseas, achieving the rank of captain and being graduated from the Army General Staff College and the Army School of the Line. The war left him with a chronic cough, but it also gave him the respect and friendship of military men that enabled him to bring about Forest Service-Army cooperation in World War II that was of great value to the Forest Service then and promises to be in the future.

For a time after World War I, Dave was in business in New York but the writer knows, more from impressions gained from general comment on Dave's part than from any direct statement, that his years in that highly competitive and materialistic hurly burly were the least happy of his life. On the other hand, while it was still an official secret the writer learned that Dave was to succeed Pat Thompson as Chief of Fire Control. He went to Dave and stuck out his hand, without a word. Dave's handsome face lighted, he took my hand and said, "Thank you, Alan." That was all. but there was about him the air of a man who had achieved the position that he wanted more than any other—Chief of Fire Control in the United States Forest Service.

To an old newspaperman like the writer, Dave had one characristic that seemed particularly valuable. He had of course a strong islike for inaccurate, sensational statement, and I think never felt uite comfortable when stories for newspapers were being prepared. et for all that he realized the value of publicity—for all its freuent and often unavoidable errors—and he handled newspapermen ith great patience and respect, giving of his ideas and time to the tmost whenever required. He was particularly good in this connecon when talking about the "smoke-jumper" program, the use of irplanes and other equipment in forest fire control, direct, informave and full of his subject. And in that hectic world of newspapermen e had his accolade. The writer does not know how many men came him with a word about Dave Godwin in the National Press Club ollowing his death, but there were many. To men who are always lking about "stuffed shirts" and "cheap skates" and "publicity ounds," Dave Godwin was "a grand guy."

Progress Report on Smoke Masks and Goggles.—A study was made of available ommercial smoke masks and goggles to determine the most efficient mask for orest fire fighting. The final tests and analysis were made by Engineer E. E. amodt. The five most promising masks were used on a peat fire in the fall of 46. This test demonstrated conclusively that a fire fighter properly equipped ith mask and goggles could do a more efficient job and remain on the fire line nder conditions that could not be tolerated for long otherwise.

The tests indicate that goggles of any kind are of considerable value. No reat difference in the effectiveness of the different types tested could be noted. he chemical stick (pencil) and treated cloth furnished with some goggles clean and oil the glasses, to prevent moisture condensation on them, had ome slight value, and the double lens goggles with the water filler also had ome value in retarding condensation. However, not enough moisture condensed n any of the goggles to impair vision more than about 10 percent. The double ens type goggles performed equally well with or without the water filler, and ere somewhat better than any of the single lens types.

The combination goggle and mask is quite bulky and is not as desirable as e separate units.

The Pulmosan mask, No. GR–250, which costs $6.86 with built-in goggles and equipped with a small chemical can cartridge for absorption, was considered be the best all-around mask tested. It was superior to the Cover's mask, the upor mask, and the Army's M4A1 Carrier gas mask. The ordinary hospital otton gauze mask, which costs about 20 cents, proved to be about equally as ffective as the Pulmosan mask. This gauze mask, kept wet with water, appears provide all that is needed in a mask by a fire fighter. From a sanitary point f view, it can be thrown away after use. Several can easily be carried in a ocket, and they can be purchased in most drug stores. We propose to adopt e Hospital Gauze Mask as standard for use in Region 9.—J. M. WALLEY, *Fire ontrol Chief, R–9, U. S. Forest Service.*

THE FOREST FIRE HAZARD IN THE SUNSPOT CYCLE

William M. Morris

Forester, Land Economic Inventory and Land Use Section, Wisconsin State Department of Agriculture

That sunspots affect the weather is no longer a matter of conjecture or debate. Numerous studies have shown that the number of sunspots increase to a maximum and decrease to a minimum in cycles and weather changes occur in similar cycles. The sunspot cycles and the accompanying weather variations can now be predicted with reasonable accuracy. These weather variations materially affect the forest fire hazard. By knowing when the cycles of bad fire weather will occur, the forester can better plan his land management and protection practices to anticipate the periods of high hazard.

This study, made in Wisconsin by the author, indicated that nearly all of the great fires in the State occurred during periods of declining sunspot activity. The relationship between sunspot activity and weather variation in Wisconsin may be different from that in New England or the west coast. Weather records for each section of the country should therefore be analyzed individually. The work reported in this article should be considered exploratory only and subject to revision.

Sunspot Cycles

The occurrence of cycles and their length were demonstrated by a curve made from sunspot observations for 100 years at Zurich, Switzerland. The cycles based on this curve are given from one maximum sunspot year to the next maximum year. Between the maximum sunspot years of 1837 and 1937, nine complete cycles occurred. This makes the average length of a cycle 11.1 years, though the duration varied considerably from 9 to 13 years.

Besides the so-called 11-year cycle in sunspots, which is the common and most apparent one, there are undoubtedly longer trends when sunspot numbers are much above or much below normal over an extended time. Such long cycles seem to be accompanied in Wisconsin by generally cool, wet periods when sunspot numbers are high, and hot, dry periods when sunspot numbers are low. A study of tree rings, varves[1] in lake bottoms, and the various flood stages of the

---

[1] Varve, as defined by Webster, is "an annual layer of silt as deposited in a lake or other body of still water. As individual layers differ in thickness and character, a succession of such layers forms a characteristic group which can be identified as of contemporaneous deposition in whatever deposit it may be found. It is thus possible, by combining different sections, to measure the time involved in the deposition of the entire group of sediments and to construct a time scale in a manner similar to that employed in the study of annual rings in trees."

Nile River substantiates the possibility of these longer cycles.[2] It may be noted by students of the subject that the longer cycles are nearly always multiples of the 11-year cycle.

Weather Periods

In comparing the records of sunspots for over 100 years with Wisconsin weather conditions for as long as records are available, it is found that there are in general two periods of years, or two quite distinct weather seasons, which stand out in marked contrast to one another when placed in their proper position in the sunspot cycle. In these two weather periods the temperature and percent of possible sunshine received in Wisconsin show the most decided contrast though rainfall and the amount of evapo-transpiration also show distinct trends.

Weather period I is designated on the chart as the period when sunspots are increasing and at the maximum number, and weather period II when the sunspots are decreasing and at their minimum number. The first period is much shorter than the second, averaging 4.2 years since 1833, as compared with 6.9 years from 1837 to the minimum year 1944. Since 1837 a fourth year of increasing sunspots has occurred three times, and a seventh year of decreasing sunspots four times. These, therefore, have had to be shown on the chart although they do not occur in every sunspot cycle.

Weather Trends for Each Period

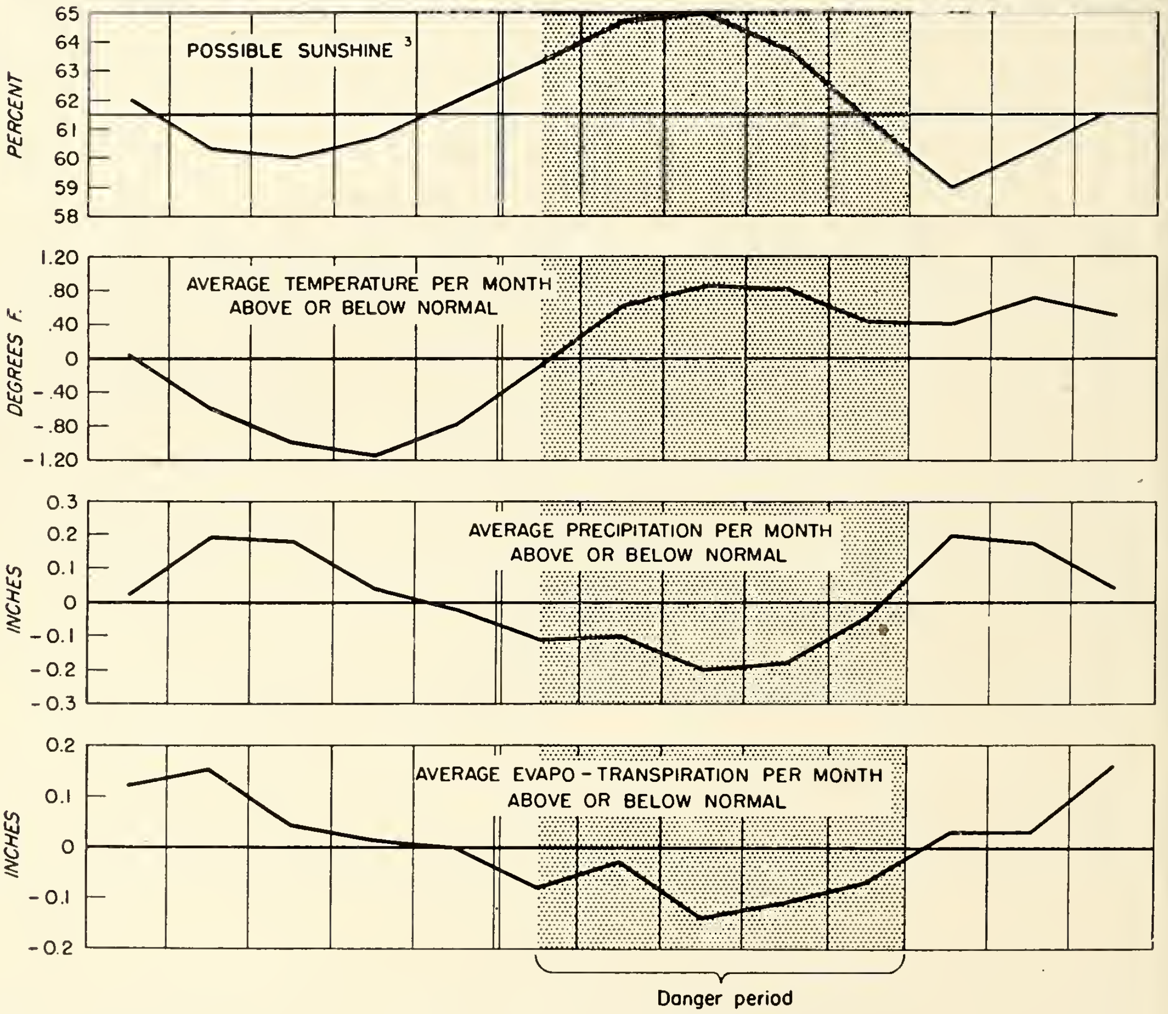
This article is confined to comparison of the weather conditions of this section of the country with the various phases of the 11-year sunspot cycle in order to determine if there is a correlation between sunspots and weather, particularly that type of weather causing forest fire hazards. Weather records have been obtainable for a longer period of time in the southern part of the State but the general weather trends for the entire State in the different years of the sunspot cycle are quite similar. For the fall months (especially October), which have proved among the most disastrous in forest fire history, the records have been taken for the past 48 years for the percent of possible sunshine, 27 years for evapo-transpiration, and 29 years for rainfall and temperature. Whether it is annual, summer, or fall weather, when averaged in the various years of the sunspot cycle the trends are similar; that is, cooler with more general rainfall the first few years of sunspot increase, hotter and drier conditions when sunspots are decreasing. At sunspot maxima, however, the summer and fall months in Wisconsin have been somewhat deficient in rainfall and cooler than in other years of increasing sunspots. At about the sixth or seventh year of decreasing sunspots there occur suboscillations in weather with opposite seasonal reactions in the atmosphere to the above general trends. The curves on the chart indicate these opposite reactions clearly. In other sections of the country these conditions may be reversed.

---

[2] Wood, S. M. THE PLANETARY CYCLES. Ill. Engin. Pp. 5–18. February 1946. Gillette, H. P. WEATHER CYCLES AND THEIR CAUSES. Water and Sewage Works 93: 252–254. June 1946.

THE SUNSPOT CYCLE [1]

Increasing Sunspots - Weather Period I					Decreasing Sunspots - Weather Period II							
First Year	Second Year	Third Year	Fourth Year	Maximum Year	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year	Seventh Year	Minimum Year
					[2]**1828**	1829	1830	1831	1832			1833
1834	1835	1836		1837	1838	1839	1840	1841	1842			1843
1844	1845	1846	1847	1848	1849	1850	1851	1852	1853	1854	1855	1856
1857	1858	1859		1860	1861	1862	**1863**	**1864**	1865	1866		1867
1868	1869			1870	**1871**	1872	1873	1874	1875	1876	1877	1878
1879	1880	1881	1882	1883	1884	1885	1886	1887	1888			1889
1890	1891	1892		1893	**1894**	1895	1896	1897	1898	1899	1900	1901
1902	1903	1904		1905	1906	1907	**1908**	1909	**1910**	1911	1912	1913
1914	1915	1916		1917	**1918**	1919	1920	1921	1922			1923
1924	1925	1926	1927	1928	1929	1930	1931	1932				1933
1934	1935	1936		1937	1938	1939	1940	1941	1942	1943		1944
1945	1946	*1947*		*1948*	*1949*	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*
1957	*1958*	*1959*		*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*		*1967*



---

[1] Allocation of dates into cycles was determined by observations on sunspots at Zurich, Switzerland.

[2] Severe fire years indicated by underlined bold face figures: 1828, Great fires in Wisconson; 1863, South Shore fire; 1864, Greatest fire; 1871, Peshtigo fire; 1894, Hinkley and Phillips fires; 1908, 1,435 fires in Wisconsin; 1910, Baudette fire; 1918, Cloquet fire.

[3] Curves are based on weather records for May through October for the State of Wisconsin.

The records of the past 109 years in southern Wisconsin indicate that summer rainfall has been average or above 60 percent of the time during weather period I when sunspots are increasing, and 43 percent in weather period II. Summer temperature is average or above 33 percent of the time in period I and 63 percent in period II. Fall rainfall has been above average 50 percent of the time in period I and 37 percent in period II, while temperature has been above average 20 percent in period I and 55 percent in period II. The general trend, therefore, is for cooler and wetter conditions in weather period I and the reverse in weather period II. Many of our hot, dry falls occur in this latter period, and when they follow a similar summer of low rainfall, high temperature, excessive sunshine, and low evapo-transpiration, a forest fire hazard is bound to occur.

The difference in the percent of possible fall sunshine received in these two weather periods is even more pronounced than it is for temperature and rainfall. In period I the percent of possible sunshine received is above the average only 35 percent of the time, while in period II it is above the average 68 percent of the time. This difference in cloudiness in the two periods may account for many of the weather conditions that are produced and has been noted by observers in other parts of the country.

These contrasting weather periods of the sunspot cycle definitely affect the growth of farm crops, such as corn, oats, and potatoes. Corn has produced its greatest yields here in periods of decreasing sunspots, weather period II, while potatoes have done best in the first period with cooler and more moist conditions.

Time of Greatest Forest Fire Hazard

The curves in the chart show a definite period when rainfall and evapo-transpiration are at their lowest and temperature and percent of possible sunshine high. Such a period should produce a relatively great forest fire hazard. This critical time is indicated by the curves as occurring in weather period II from the end of the first, through the fifth year of decreasing sunspots.

It is not true that there is no fire danger at the time of increasing sunspots. However, the danger at this time is usually modified by cooler temperatures. During the third year of sunspot increase, summer and fall temperatures have risen above average in the past, but rainfall and cloudiness were also greater. In 1881, a third year of increasing sunspots, a great fire burned over a large area in Michigan. The years 1880 and 1925 were also bad fire years in Wisconsin, but the fires did not reach the intensity or do the damage of a number of those occurring in the first 5 years of the period of decreasing sunspots. The great Mirimichi fire in New Brunswick and Maine occurred at about the same period of increasing sunspots, but weather conditions in the northeastern region of the country may be the reverse of those in the Midwest. Brush fires which burn so often in the spring with great intensity are usually quite seasonal in their occurrence, rather than governed to any great extent by the definite weather trends of the sunspot cycle.

Great Forest Fires of the Lake States

A study of the greatest conflagrations in the Lake States reveals that all of them fall within the danger period indicated on the chart. A great fire burned over a vast acreage in Wisconsin in the year 1828, a first year of decreasing sunspots. In 1863 the southwest shore of Lake Superior was burned over. In La Crosse, the sun was obscured by smoke for several days and the atmosphere was murky as far as Milwaukee. In 1864 there occurred a very general conflagration, beginning early in the season and growing more intense as the year progressed. The vast pineries of the north were nearly all ablaze. From the Chippewa, St. Croix, Black, Wisconsin, and Wolf Rivers came stories of raging seas of smoke and fire, as well as from Brown, Kewaunee, and Manitowoc Counties. Wausau, Two Rivers, and Neillsville fought off the flames only by the combined efforts of their entire population. Although this was one of the greatest general conflagrations in the State it received scant notice in the newspapers of southern Wisconsin.

The Peshtigo fire, Wisconsin's greatest calamity, occurred in October 1871. Fifteen hundred lives were lost in this fire and 1,280,000 acres laid bare. In July 1894 the Phillips fire killed 300 people and destroyed 100,000 acres of timber. In September of the same year, Hickley, Minn., was destroyed with 12 other towns, 418 lives were lost and 160,000 acres of forest burned.

The year 1908 was a very bad one for forest fires in Wisconsin. In that fire season 1,435 fires were reported burning over 1,000,000 acres, with a property loss of almost $3,000,000. Perhaps the greatest fire year ever experienced in the United States as a whole was 1910. This was the driest year in the records for southern Wisconsin. Fires raged in Minnesota, Idaho, Washington, and Oregon, from July through October. The largest one in the Lake States that year was the great Baudette, Minn., fire of October, which destroyed 300,000 acres of woodland and killed 42 people.

On the afternoon of October 12, 1918, fire started in the timber at Cloquet, Minn., following a shortage of 20 inches of rainfall in the preceding 20 months. Duluth was threatened, and smoke filled the air even in the southern part of Wisconsin. Four hundred lives were lost and property damage reached $30,000,000.

These are nine of the greatest recorded fires and fire years of the Lake States. A check on their position in the sunspot cycle shows that five fall at identically the same location in the cycle, namely, the last part of the first year of decreasing sunspots after sunspot maxima. All of them have occurred in the first 5 years of decreasing sunspots, that is, in the danger period shown on the chart. This relationship can hardly be a coincidence.

Importance to the Forester

In order to predict the periods of greater danger it is necessary to know the years of sunspot maxima and minima. The best authorities are not fully agreed as to the next year of maximum but place it anywhere from 1947 to 1949. On the chart it has been placed at 1948. This should be correct within a year, as also with the other predicted dates. If the maximum occurs in 1947 the dates on the chart should l be shifted to the right one year. Sunspot years and calendar ears do not coincide and this accounts for some difference.

Hotter and drier periods should occur from 1949 to 1953 and again om about 1961 to 1965, according to weather conditions of past nspot cycles. The forester should take advantage of this knowledge f periodic weather conditions. During the longer periods of sunspot ecline, when drought and heat are apt to prevail, he should be espe-ally alert for fire hazards and be careful not to create any. Slashings s a result of timber sales would be a much greater hazard in these years han during the cooler and moister years of increasing sunspots. At ch times more rigid rules pertaining to slash disposal and timber les should be enforced. The forester could also go lighter on forest lanting or perhaps not plant at all. At any rate he could exercise ore caution and be more painstaking with nursery stock or any forest lanting. Especial care should also be maintained before and at nspot minima which are often excessively dry in the Midwest.

Weather Predictions

The above information as a means of future general weather pre-ictions is based on a study of past weather records as far back as vailable. These records of calendar years are placed in the various hases of the sunspot cycle and averaged. Curves made from these gures can be used as a basis for future general predictions. They hould be worked out separately for various sections of the country.

This work so far is of an exploratory nature only and is subject to evision. Studies in other parts of the world have corroborated its eneral principles. It will be of great interest, therefore, to check and nprove its accuracy by a further study of the weather conditions of ne future sunspot cycles. It should prove of value not only in de-rmining the forest fire hazard, but in all branches of forestry such s silviculture, insect control, and forest pathology, as well as in many her walks of life.

A Smoker Fire Prevention Campaign That Paid Off.—Six major logging opera-ons in the Modoc Forest have made the problem of smoker fires in the operat-g areas serious. In 1943 there were 18 smoker fires on logging operations ith 13 of these occurring on the Ralph L. Smith Lumber Co. operating area.

In 1944 Mr. A. B. Hood of the Ralph L. Smith Lumber Co. proposed a mpaign for *Safe Smoking*. The company had posters printed at their own xpense and carried out a campaign to educate their employees into *Safe Smok-g* habits. The campaign emphasized that woods workers should smoke *only* cleared or posted areas. In addition, the company deposited cooperative pre-ention funds with the Forest Service to pay for a prevention patrolman. This an worked under the supervision of the Forest Service and made intensive atrols of the logging area and contacted all woods workers to promote the *afe Smoking* campaign. The results were spectacular with occurrence drop-ing from 13 in 1943 to *none* for the years 1944, 1945, and 1946.

In 1945 the other 5 operating areas had 13 smoker fires. The operators were ntacted by the Forest Service and agreed to follow the *Safe Smoking* campaign their areas. The results were very good, with smoker timberman fires reduced 2 for the entire Forest in 1946.

The key to the program is not to deny the woods workers the privilege to noke but to educate them to smoke *safely* at a cleared landing, dirt road or ecial cleared area in the woods. This is very effective except for the occa-onal habitual smoker who might automatically, and without conscious thought, ght up and smoke in a dangerous spot.

Legal action against these unsafe smokers is probably the only way to cure em.—Russell W. Bower, *Fire Control Officer, Modoc National Forest.*

ADAPTING THE "WEASEL" TO FIRE CONTROL

E. A. Grant

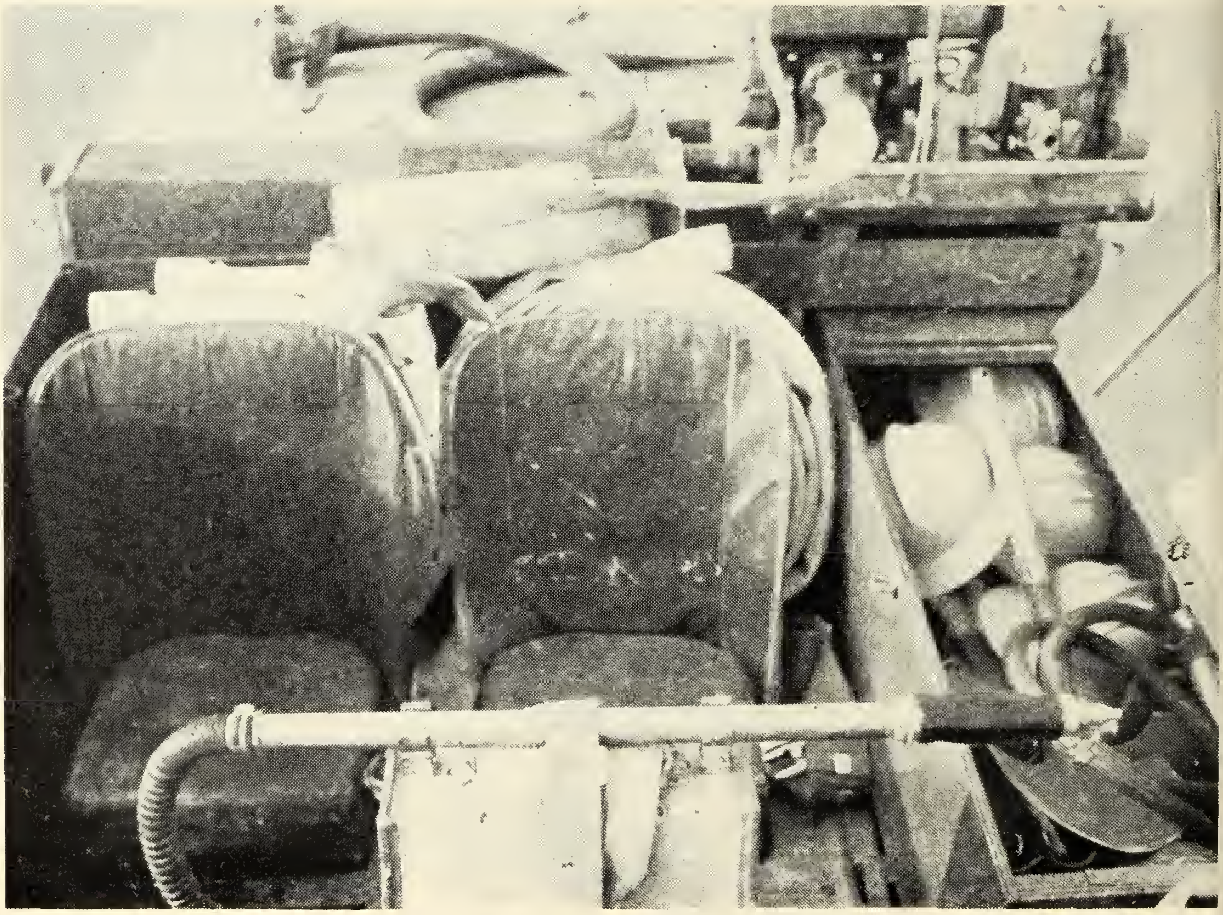
Fire Control Officer, Angeles National Forest

The Army amphibious "Weasel" (Cargo Carrier M 29C) had possibilities for fire control work, but how could it be reconverted?

This track laying, amphibious unit should be able to carry crews or equipment across relatively still bodies of water as it was so designed originally. Such a problem faced the Angeles Forest last summer, when water was backed up by a flood control dam in the San Gabriel River. The high water blocked off a road up the East Fork of the river threatening a suppression crew on the west side of the main river with a 30-mile drive with tanker equipment to reach a possible fire just across the canyon. The weasel offered a solution.

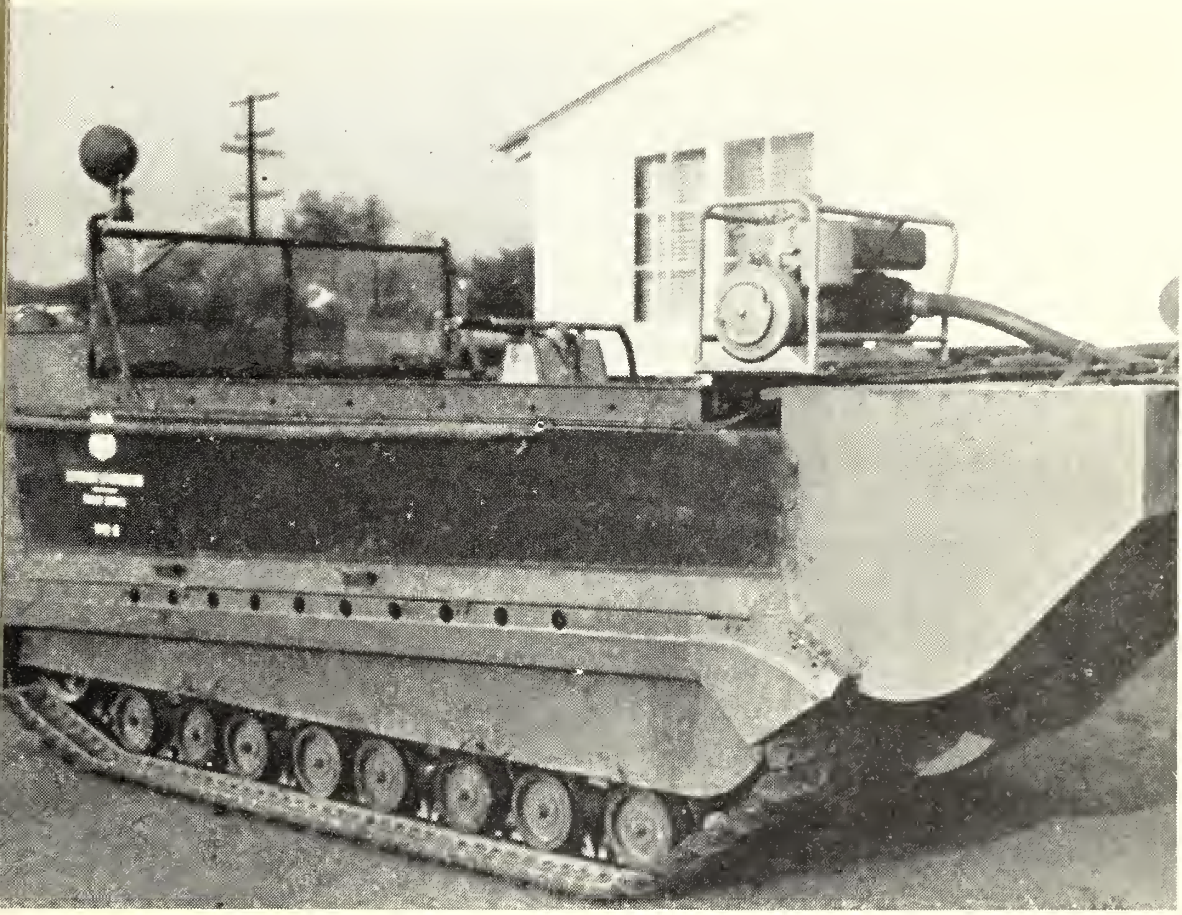
After careful thought and several tryouts in another nearby flood control lake, the equipment was selected and distribution of weight was promptly made to allow the weasel to float level in the water.

To meet fire control requirements, the unit must carry the necessary hand tools, canteens, and back-pack pumps. Then, to make it thoroughly useful, and to take advantage of the water it would be used in, a portable pump and sufficient hose to reach a lakeside fire were needed.



Tool arrangement on weasel.

When resting in water, the weasel has a freeboard of only 8 inches rom the water surface to the top of the passenger and engine compartment. Possible swamping of the unit is ever present. Life jackets ere obtained for personnel protection. As safety of personnel was ore than just to prevent drowning, a box was required to hold e tools. The entire equipment was weighed item by item, and the easel passenger compartment was stripped of miscellaneous fixture, ch as one steel bucket seat, miscellaneous brackets, and so forth, to ffset the equipment weights and to keep the lowest possible gross eight.



Portable pump mounting on weasel.

Equipment carried in the tool box included two double-bitted axes, wo ladies' shovels, two brush hooks, two Pulaski tools, two McLeod ools, and four safety helmets. A back-pack pump was mounted on bracket in front of the two bucket seats, while a 5-gallon can of oil ixture for the portable pump was placed in front of the tool box. wo hundred and fifty feet of hose was placed behind the bucket seats.

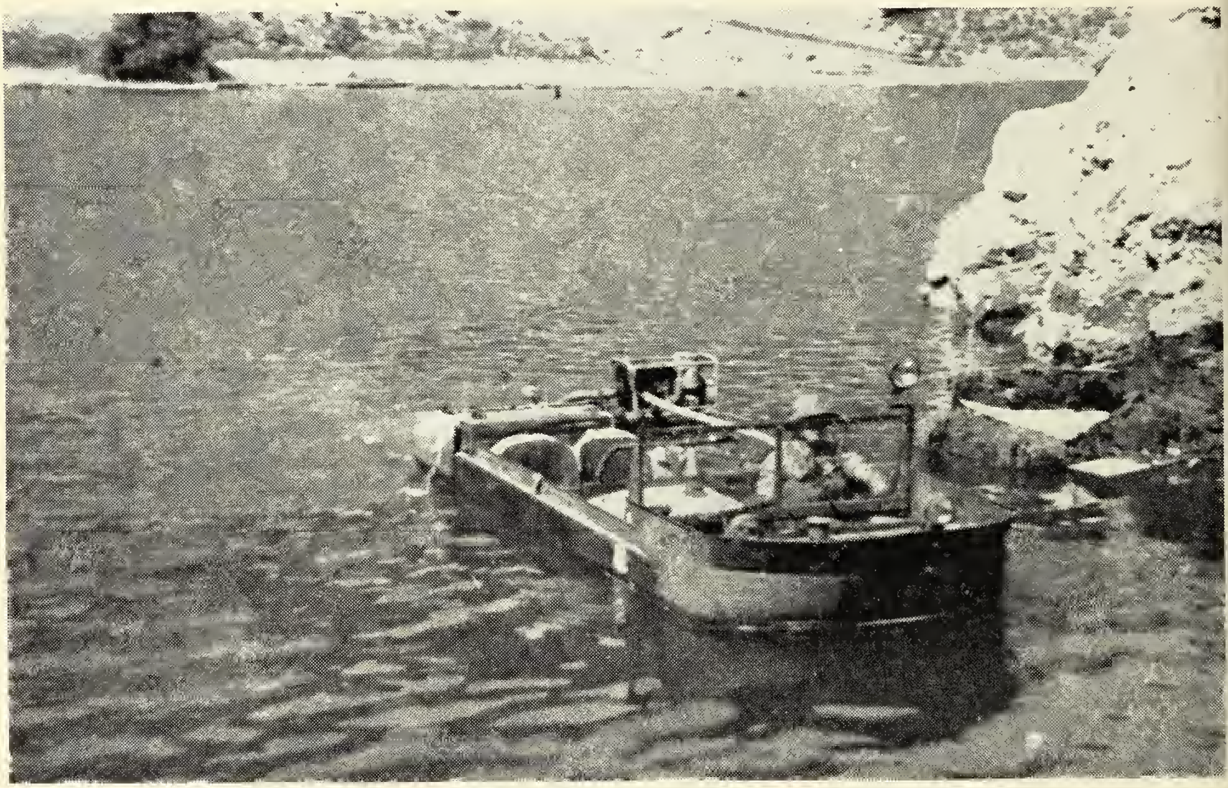
The portable pump was mounted on a special bracket over the rear nd of the weasel proper and the rear float tank. The suction hose as looped and strapped to the top of the rear float tank in such maner that by unfastening one strap the strainer was dropped into the ater between the two rudder controls. The pump exhaust, because f its water cooling system, was piped to the opposite side of the weasel here it was discharged overboard. This discharge outlet is behind he regular exhaust and muffler and is protected by the muffler's screen esh wire protector.

During the actual tests in the water with all tools and equipment in place, the weasel rode level. It demonstrated its adaptability to water work, traveling at a speed of approximately 4 miles per hour.

It was also tested in wet sand wash where any other equipment would have bogged down completely and came through with flying colors. In dry sand it did not hesitate.

As for hill climbing, the weasel has been tested on grades up to 71 percent, where it was stalled, not for lack of power, but for lack of traction.

There are some danger points to be watched in the use of this type of equipment. The possibility of swamping while in water must always be considered. All personnel should be required to wear life jackets at all times when the unit is in water.



Loaded weasel being tested.

The braking system is not in proportion to the power of the motor in the unit. The unit will go up steeper slopes than the brakes will hold on when coming down. Auxiliary brakes are required, and these are being developed by the Equipment Development Center at Arcadia, Calif.

The weasel will go through heavy oak brush up to 10 feet high and with stems up to 1½ inches in diameter; larger stems have a tendency to foul the tracks.

In entering the water, the weasel must enter at right angles to the slope of the ground. If one side touches bottom first, the angle of repose may swamp the unit. Underwater obstructions must also be avoided to prevent rupture of the float tanks or the watertight bottom of the unit.

With float tanks removed the unit has been given a baptism of rescue work on the desert near Twenty-Nine Palms, Calif., bringing in nine Air Rescue Service personnel exhausted from hiking under the desert sun in midsummer for 3 days.

The demonstrations described above have shown that a fast crawler-type amphibious vehicle has its place in fire control work. It has possibilities beyond being a piece of suppression equipment such as described here. It can be made into a personnel carrier, which will take overhead or crews up fairly steep hillsides, and so reduce fatigue. By installing a pump and tank in the cargo compartment it will make a fast crawler tanker.

It is a machine of utility to the fire control work, traveling at 32 miles per hour on highways. Night use is also possible with the addition of the proper headlights and taillights. The value of such a vehicle in suppressing swamp fires should be obvious.

A Common Fire Control Fallacy.—Many learned theses have been written on forest fire control. Perhaps too much has been written and too little done. To dispel the idea that this is just another one I want to say right here and now that this is not learned and it is not a thesis. It's just a random thought that perhaps isn't even orthodox.

It's orthodox to consider forest fires as an evil (so far I concur). It is also customary to believe that we will always, or for a great many years to come, have forest fires with us in great numbers, and that we can expect no real decrease in number until most of the old timers who have been accustomed all their lives to burning the woods die off or become too feeble to run the ridges or set fire to a brush pile (and that's the bunk).

Most of the old timers that I knew when I was initiated into the fire game have died and gone to—well wherever these old woods burners go—many years ago. What were then the members of the coming generation from which so much was expected now are the old timers who are still burning the woods. We are now waiting for something to happen to them. Apparently we always have these "old timers" standing between us and our goal of adequate fire control. Why wait any longer? To anyone who says they can't be educated, I'll say that it can and has been done, in one way or another.

Of course it's easier to give a talk and show some pictures to 30 or 40 moppets than to walk up the hollow a few miles to find the old man of some of them, see what makes him tick, and diagnose his case. He's the guy that's doing the devilment and with whom we are currently concerned. Having shown our pictures and said our little speech we console ourselves with the thought that we are making it easier for the next generation of foresters, and then hurriedly muster a crew to stop the fire that got away from the old man while we were thus laboriously preparing for the future.

Work with the youngsters is highly important and far be it from me to minimize its value but it is not more important than working with the old timers whom we are too prone to consider a lost generation so far as fire control is concerned.

Nor should we overlook the fact that perhaps the old man has ways and means that we know not of, or if we do are not permitted to use, of influencing his progeny. I know that the current idea is to "reach the parents through the child" but this has been known to work in reverse and more effectively too than some child psychologists would have you believe.

When I hear that old and oft repeated story about waiting for the old generation of woods burners to die off, it leaves me pretty cold. It's the same old alibi that was used a generation ago. The new generation of foresters should have sufficient ingenuity to think up a better one than that.—S. H. Marsh, *Inspector, Region 7, U. S. Forest Service.*

FOREST FIRE STATISTICS: THEIR PURPOSE AND USE

J. A. Mitchell

Fire Research, Lake States Forest Experiment Station[1]

Statistics may be defined as organized factual information, particularly information which can be stated numerically. Their purpose is to present related facts, so classified as to provide a basis for sound conclusions or inferences.

Reliable information is the foundation of effective effort—hence the need for adequate and dependable forest fire statistics. They are essential first of all to determine the need for fire control; second, as a basis for protection planning; and third, to properly gage the results of fire control effort. Incidentally, they provide a valuable historical record and data needed to solve many fire control problems.

While usually conceded to be desirable, the value and importance of good forest fire statistics is not generally appreciated. The significance of statistical information is often not apparent until it has been compiled and interpreted. This takes time and effort. As a result, if interest is lacking, compiling and interpreting are put off.

Another reason for our lack of good fire statistics is the fact that, until recently, there has been a deficiency of reliable base data. This has been, and in some cases still is, a serious handicap as anyone who has tried to compile such information well knows. This is no excuse, however, for not making the most of what we have; for even meager data, if properly analyzed, afford much valuable information. Until the need for better data is recognized also, our records will continue to be inadequate.

On the other hand, few realize how much factual information actually is available. The individual fire reports, both State and Federal, for example, contain a world of valuable data which for the most part has never been compiled or analyzed beyond the meager requirements of the Clarke-McNary and Federal annual fire reports. Once the required information has been extracted, these reports are too often relegated to the closed files and forgotten. What is more inexcusable, the reports are not always preserved, with the result that attempts to utilize them later are frustrated by gaps in the record.

Another source of vital information which has received even less attention is the daily fire-weather record. The Forest Service is equally remiss with the States in failing to compile and utilize the information these records contain. Yet what other sound basis have we for comparing the severity of fire seasons and determining the intensity or protection called for by protection units.

---

[1] Maintained at the University Farm, St. Paul 1, Minn., in cooperation with the University of Minnesota.

Without knowing the conditions prevailing, how can we hope to plan effectively or judge properly the results of protection effort? How does this season compare with last? We had more fires and area burned, therefore we say it was worse. But did we have more fire days or higher danger? If we did, the poorer record may be justified. If not, we have been slipping and there is some reason to believe that this is the case. Again, the record for the past 5 years on the whole has been excellent and we have been patting ourselves on the back and thinking that we have the fire problem licked. But have we? Isn't it possible that favorable conditions rather than more effective effort are responsible? What would have happened if conditions had been the same as in previous bad years? We may just be kidding ourselves and, when conditions are really bad again, will find that we are not as good as we thought we were. These are just a few examples of our lack of elementary information that adequate fire statistics would supply.

It is true that statistics will put out no fires and that much time and effort can be wasted on their compilation. Without specific information, however, fire control is a matter of guesswork. To the extent, therefore, but only to the extent that they serve a useful purpose are fire statistics justified and their compilation and analysis warranted.

How far a protection organization should go in compiling and analyzing its fire data depends on conditions and the intensity of fire control in effect. The purpose of this paper is simply to point out the significance and use of statistical information in fire control.

In addition to furnishing a historical record, the purpose of fire statistics is to provide specific information as to where, when, and why fires occur and a basis for comparing seasons and protection units and judging the results of protection effort. The essential data are location of fire, date of occurrence, cause, conditions prevailing, action taken, area burned, damage, and cost. This information, in more or less detail, is given in most individual forest fire reports.

The basic statistics derived from these data are number of fires, area burned, loss, and cost.

All other fire statistics, with a few exceptions, are elaborations of this basic information. For example, some or all of these items may be broken down by political or administrative units, by land ownership, intensity of protection, season, cause, type of cover or conditions prevailing, and they may be presented graphically or as totals, averages, or percent.

At present the only forest fire statistics generally available are those compiled annually by the Forest Service, Division of State Cooperative Fire Control, or contained in State and Federal reports. Some States, it is true, break this information down by protection districts and months. Only a few, however, go into any greater detail.

As a matter of record and for general information, these statistics are fairly adequate. They also serve to show the relative over-all size and importance of the fire problem by States. Without further breakdown and elaboration, however, they fail to answer many important administrative and operational questions and do not provide an adequate basis for judging results. A minimum of fire data essential to serve these needs are shown in the check list that follows.

CHECK LIST OF ESSENTIAL FOREST FIRE STATISTICS

(By protection units and years)

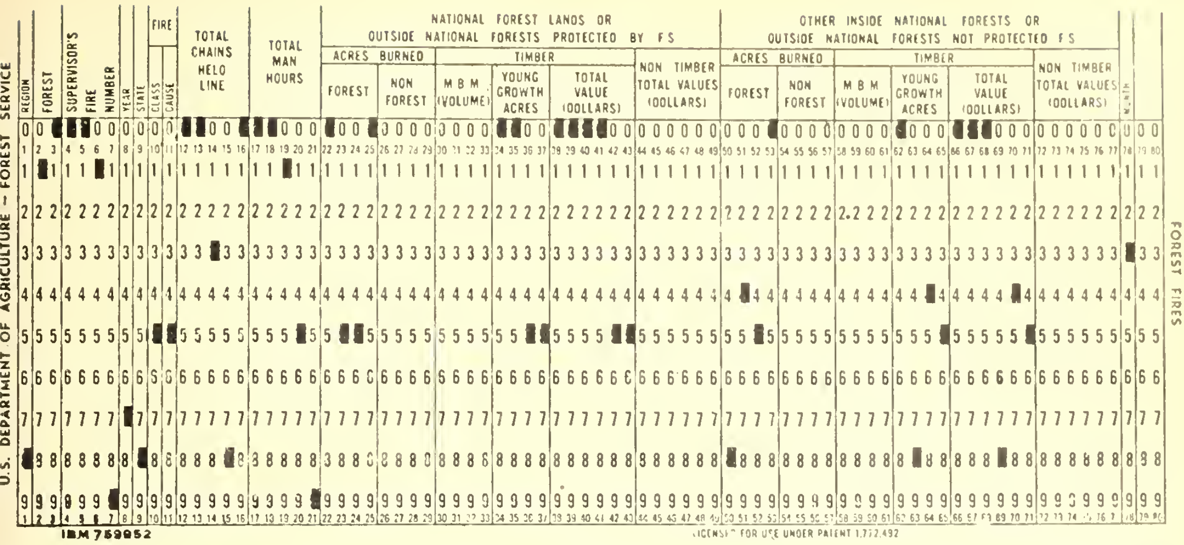
- Basic statistics:
    - Area protected:
    - Number of fires: Total and by
        - Cause (lightning, railroads, etc.):
        - Size class (A, B, C, etc.):
    - Area burned: Forest, other, and total.
    - Loss: Forest, other, and total.
    - Cost: Presuppression, suppression, and total.
- Calculated statistics:
    - Danger prevailing (over-all seasonal rating):
    - Risk of fires starting (number of fires per unit area):
    - Risk of fires spreading (size of average fire):
    - Risk of burning (percent of protected area burned over):
    - Destructiveness (loss per acre burned):
    - Risk of loss (loss per acre protected):
    - Presuppression cost per acre protected:
    - Suppression cost per fire:
    - Effectiveness of suppression (percent of fires under 10 acres):
    - Loss plus cost per acre protected (presuppression and suppression costs plus destructiveness):

At the regional level, in addition to the information now compiled, we should have by States and by years all the calculated statistics. At the State level the same information is needed by protection units.

In addition, for sound protection planning, we need to know by protection districts the distribution, concentration, and seasonal occurrence of fires; the normal number of days in each danger class; the normal duration and severity of the fire season; when, where, and how frequently abnormal conditions occur; the variation from normal to be expected; the distribution, concentration, and seasonal occurrence of fires by cause, size class, and fuel types; and many other facts that only a proper analysis of available fire data can supply.

To compile and organize this information by hand is a laborious and time-consuming undertaking and one that becomes more so as records accumulate and data increase in volume. The most practical answer is machine tabulation. While few States have sufficient use for tabulating equipment to justify its installation for this purpose alone, such equipment in some cases is available in other departments or commercially. Another possibility is for a group of States to cooperate in maintaining a tabulating center that would serve them all. The Washington Office of the Forest Service has handled national forest fire statistics in this way for several years and it has not only simplified getting the information desired, but has relieved the supervisors and regional offices of the burden of compiling and tabulating this material.

The machine method of tabulation has many advantages. It not only simplifies and expedites the compilation of required information, but special summaries and tabulations can readily be made at any time, thus aiding in the analysis of the fire problem. The method also has great flexibility and is adaptable to a wide variety of needs, since once the basic information has been entered on punch cards it can be classified and tabulated whenever and in whatever way is desired.

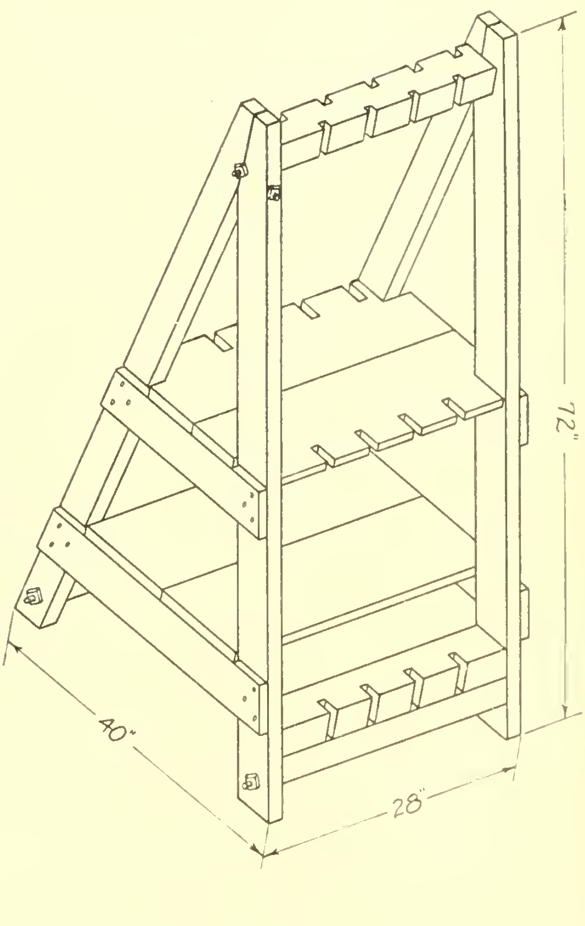

U.S. DEPARTMENT OF AGRICULTURE – FOREST SERVICE
REGION
FOREST
SUPERVISOR'S FIRE NUMBER
YEAR
STATE
FIRE
CLASS
CAUSE
TOTAL CHAINS HELO LINE
TOTAL MAN HOURS
NATIONAL FOREST LANDS OR OUTSIDE NATIONAL FORESTS PROTECTED BY F S
OTHER INSIDE NATIONAL FORESTS OR OUTSIDE NATIONAL FORESTS NOT PROTECTED F S
ACRES BURNED
FOREST
NON FOREST
TIMBER
M B M (VOLUME)
YOUNG GROWTH ACRES
TOTAL VALUE (DOLLARS)
NON TIMBER TOTAL VALUES (DOLLARS)
FOREST FIRES
IBM 759852
LICENSED FOR USE UNDER PATENT 1,772,492

Punch card used by the U. S. Forest Service in tabulating forest fire data.

Since most people are allergic to figures, statistics often fail of their purpose. The remedy is to abstract the essential facts and to present them in more appealing form, either as a running story or by graphs and charts. Graphs and charts are especially useful in comparing conditions and results and in bringing out the significance of specific facts. A running account on the other hand is usually more suitable for presenting general information. Adequate statistics, however, are essential as source material in either case as well as for reference and analysis.

SAW AND ACCESSORY RACK FOR WAREHOUSE USE

A movable crosscut saw rack, as diagramed, is easily made of 2 by 4 and 1-inch lumber to accommodate any number of saws desired. Shelves built inside the frame strengthen it and also give storage space for wedges, handles, and saw guards. The notches which hold the saws are offset so the top ends of the saws clear each other. These notches are ¾ inch wide, 1 inch deep in the top 2 by 4, and 2 inches deep in the top shelf and bottom 2 by 4. A ¼-inch rod through the top and one through each side just under the piece that holds the lower ends of the saws makes the rack more rigid. Aside from the neat appearance the rack provides compact and complete storage for all crosscut saw equipment and can be located in odd corners of the warehouse.—Elvin R. Fellows, *Fire Control Assistant, Stonyford District, Mendocino National Forest.*



TRAINING HIGH SCHOOL BOYS IN FIRE SUPPRESSION

John D. Whitmore

General District Assistant, Glenwood Ranger District, Jefferson National Forest

The manpower shortage brought about by the war is still familiar to everyone who was responsible for recruiting manpower during that period. The warden organization was practically depleted. Private industries which had agreed to furnish manpower for fire fighting were reluctant to close a plant and release their men.

We had a group in our high schools who came from the rural districts. These boys were husky fellows who could do a good job fighting fire if they were properly trained. There were still enough "old men" left in the warden crews to head up groups of 10 or 12 of these boys. So it was decided that the boys should be organized into crews of 10 or 12 with a group leader to work under the direction of a warden or other experienced fire fighter.

Our first attempt at organizing and training high school boys confronted us with several unforeseen problems. First, we found that many principals were unable to see the value of the program and were reluctant to have their school curriculum interrupted. Another problem was to coordinate the efforts of the United States Forest Service with those of the State so as to avoid duplication in the work and to avoid the confusion that was bound to result from having both agencies trying to work independently with each school. A third difficulty was to find a way to get the job of organizing and training done within a reasonable expenditure of time.

It was not easy to overcome the principals' resistance. It has finally been accomplished in most cases by repeated personal contacts, by using patience, and by becoming well enough acquainted with the principal so that we could talk as friend to friend rather than as an impersonal forest officer to a harassed schoolmaster. Contacts by the Forest Supervisor and the State forester to county and State officials of the board of education helped to start the program, but good personal relationships between the men on the ground was the secret of success.

Coordinating our efforts with those of the State was an easy problem to solve. The district ranger and the State district forester agreed that the United States Forest Service would be responsible for training at the 10 high schools nearest the National Forest, that the State would cooperate with us in this training, and that both agencies would be privileged to use the crews. We have found this to be a very satisfactory arrangement. In this way the schools are contacted by only one agency with the result that the interruption of the school program is kept to the minimum.

With the school principals working on our side, and with a definite working agreement with the State forest service, we can now carry on our school program in a manner that is almost routine. The third problem—that of finding time to do the job—has been largely solved by our having a definite schedule so designed that other district work can be done in conjunction with the high school training. The following schedule shows how we do the job on the Glenwood District.

SEPTEMBER 15–30

Truck is loaded with tools for making replacements in warden boxes; paint for boxes and signs; and material for checking and repairing wardens' telephones. The trip is made, taking the wardens as we come to them. A complete job is done at each warden location at this time. That is, tools are checked, poor tools replaced, sign and box repaired and painted when necessary, telephone checked for batteries, etc. A check up is made on the warden crew and its transportation, and revisions are made where necessary. Each high shcool to be organized is contacted and a date for training arranged. These dates are arranged so the training can progress from day to day. At the time this contact is made, parents' consent forms are left to be signed.

OCTOBER 15–30

Spend one day at each school on the following schedule:

9 a. m. Arrive at school. Assemble entire school if possible, girls as well as boys. Give short talk to group as to our purpose at school. Point out good work done by schools in prevention and suppression. Show motion picture to group. Picture should be general conservation film dealing with wildlife, soil, and timber products as well as fire control.

10 a. m. Assemble prospective crew members in classroom. Get principal's idea on desirable crew leaders. Discuss purpose of organized crews and work expected of them in prevention and suppression work. Explain connection between Federal and State fire control work and the difference in wage rates. The county warden should have comments.

Elect crew leader and assistant crew leaders for each 10 to 12 boys. Get names and addresses of all crew leaders. After the crews are organized, spend some time discussing ways of doing prevention work.

Turn job of poster and bookmark distribution over to the crews. Give specific instructions as to where posters will be put up.

11 a. m. Travel to training area in stake truck. Maintain the same order on truck as expected on trip to fire. Take principal or agriculture teacher if possible. Unload tools. Lay them out in same order as used on fire. Explain name of each tool, purpose of tool, proper and improper use, and safety hazards involved. This must be done through demonstration.

12 p. m. Lunch.

1 p. m. Explain organization of crews, line construction, and duties of each man. Ask and answer questions. Return tools to truck and pack in box.

2 p. m. Hold class in conservation work. Show why we prevent fires; the effect of fire on timber and soil; how fire affects the individual. Using an increment borer, Biltmore stick, tape, and Abney level, show how national forest timber is managed and sold. A good location for this discussion is adjacent to a burned area.

Return to school. Give each crew member some good literature or a bulletin to take home.

3 p. m. Have discussion with agriculture teacher and principal. Talk about his job as well as yours. Give him a picture of the job we are doing and how he can fit into it. Spend the necessary time with him to get acquainted.

Let him know you will be back in the spring.

4 p. m. Line up transportation for the crews. Replace No. 1 posters. Do general contact work.

FEBRUARY OR MARCH

Contact schools. Assemble crews in classroom. Take approximately 30 minutes to distribute posters, bookmarks, etc., and give boys pep talk. Check any change in crew and transportation. Contact county school superintendent on this trip.

We have found it to be workable and practical. Notice that much of the program is devoted to prevention work. We have the boys distribute all posters and prevention literature. It is felt that this part of the training pays off by creating interest and making fire-conscious citizens out of these boys who are going to be the leaders in our communities in the near future.

Accurate records have not been kept of the extent these high school boys have been used in fire suppression. But it can be safely said that they have helped us out in times when it seemed almost impossible to recruit even a small warden crew. The principal of one high school has kept a record of the fire fighting he and his boys have done. His record shows that the boys went to 94 fires and 16 false alarms; spent 4,787 manhours fighting fires; traveled 2,730 miles; and received $1,627 in wages. It is interesting to note that all but 19 percent of the time spent by the boys was outside of the regular school hours.

Air Operations Handbook: Cargo Dropping.—Cargo Dropping, a 58-page multilith pamphlet, has been prepared by the Division of Fire Control in Region 6 as one of the chapters of the Forest Service Air Operations Handbook. Factors governing the use of airplanes for dropping cargo in the fire-control system are given briefly. Included in the pamphlet are details of cargo-dropping equipment, how to package and load cargo, methods of transporting and discharging cargo, selection of the cargo-dropping area, and the organization necessary to do a given job. The pamphlet is not yet in final form but was printed in limited quantity to avoid further delay in meeting operating needs this season.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

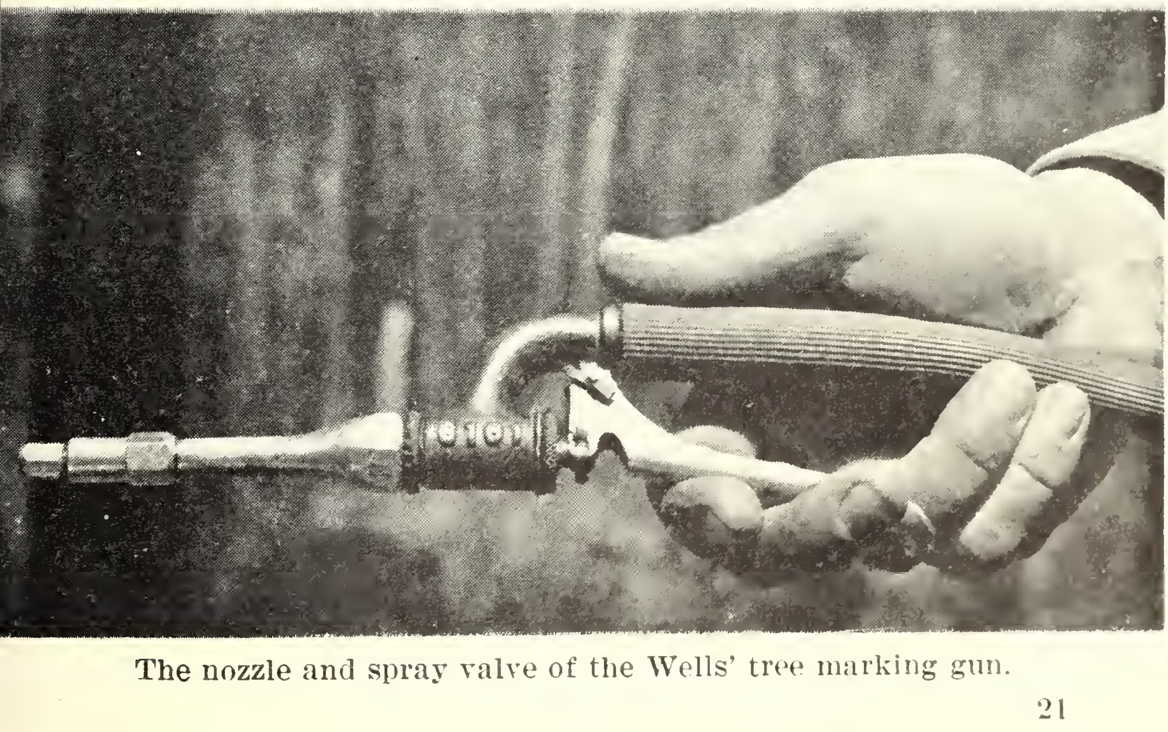
COMBINATION TREE MARKING GUN AND BACKFIRING TORCH

A. C. WELLS

District Assistant, Francis Marion National Forest

This combination marking gun and backfiring torch was developed
rst as a paint marking gun. The conventional hand oil stream gun
ecessitated carrying extra paint in a container or returning to a cen-
al point for refilling. These operations were time consuming and
was felt that they could be reduced. In addition, the hand oil
ream gun required a considerable pull on the trigger in order to make
mark on the tree. A complete stroke was necessary, thus, there was
control over the amount of paint used per mark. All of the above
bjections have been overcome in the development of the Wells' paint
un which is operated by air pressure. After the gun was completed,
e backfiring attachment was developed in order to utilize the abili-
es of the gun.

The paint gun is made from a Montgomery Ward garden club
prayer with a capacity of 2 gallons and an empty weight of 7 pounds.
his sprayer costs $6.39. It came equipped with a spray nozzle and
ntrol valve which proved unsatisfactory for our purposes. A Myers
pray valve costing $1.35 was put in place of the original valve, and
e nozzle from the hand oil stream gun was attached. Straps from
back-pack fire can were placed on the tank so that it can be carried
the back.



The nozzle and spray valve of the Wells' tree marking gun.

Operation of tree marking gun.—The air pump is extracted by turning and pulling up. Air-vent screw is loosened. Marking paint in any amount not to exceed 2 gallons is then placed in the can. Replace the pump. Replace air-vent screw and secure. All connections must be air tight. Then pump air into the gun with an up and down stroke of the pmp handle. Continue to pump until the strokes become difficult to complete. Sufficient air can be placed in the tank with from 60 to 80 strokes. Secure pump handle with clasp for this purpose. By manipulating the control lever tree marks can be made. Only 1 pumping of air is necessary to expend the entire 2 gallons of paint. Paint is completely utilized since the air pressure forces it out of the can. Even after all the paint has been expended, there is still pressure in the tank.

Advantages of the gun.—The can carries a full day's supply of paint (2 gallons). It is back mounted and easily carried. Air pressure operation reduces the work load on the trigger finger.

The gun conserves paint. The amount of paint can be controlled as it leaves the gun thus allowing the operator to use the minimum amount necessary to give a lasting mark. A test of the number of trees marked per gallon of paint revealed that in pulpwood areas the Wells' paint gun averaged 777 while the hand oil stream gun averaged 560. In saw-timber areas where a much heavier mark is necessary, especially when marking cypress and hardwoods, the Wells' paint gun averaged 650 trees marked per gallon as against 410 for the hand oil stream gun.

The marker can mark more trees per hour of marking. Less time is needed to mark each tree since air control gives a quicker mark than that of the manual trigger operation.

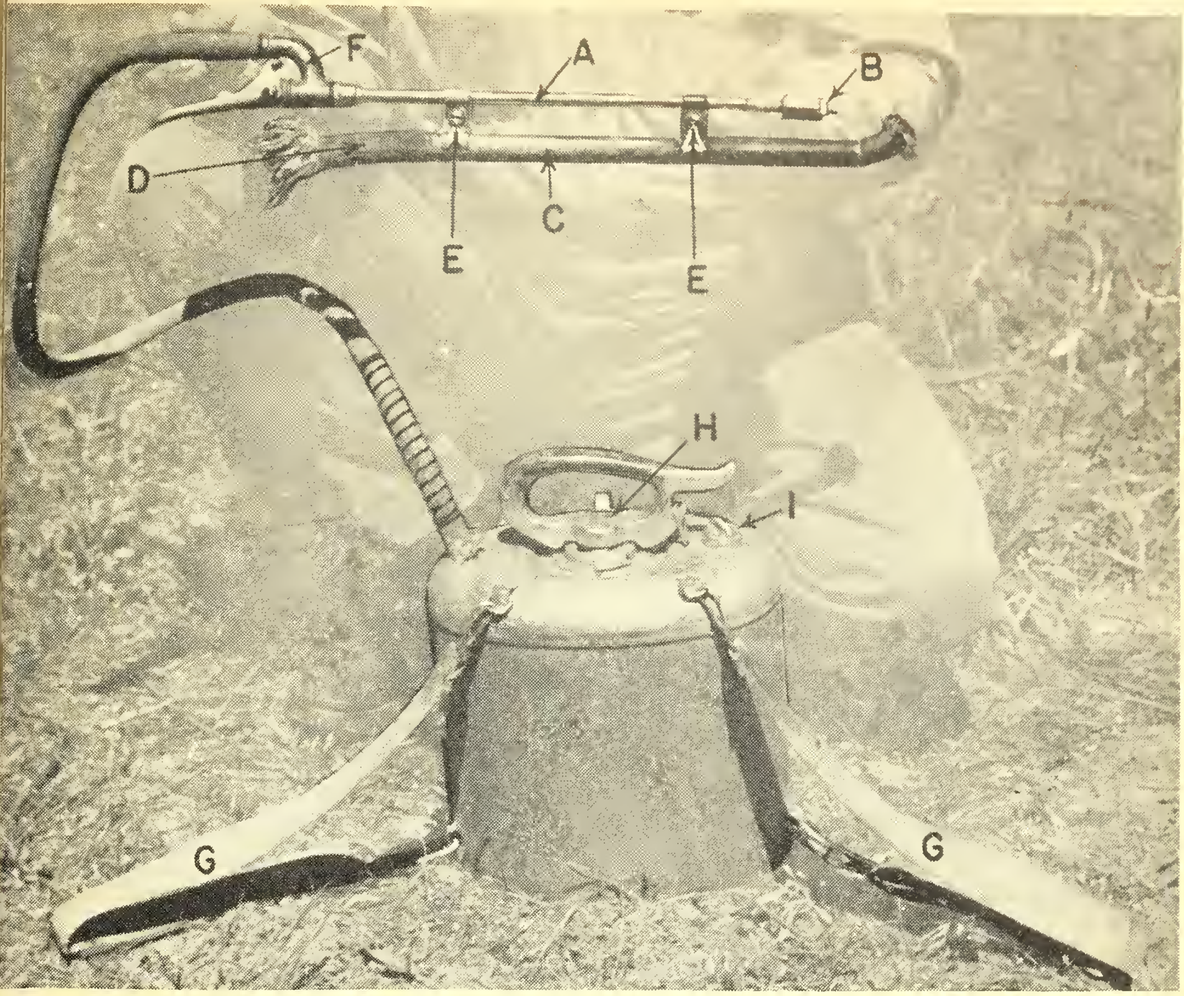
Within a matter of minutes this gun can be changed to a backfiring torch. In the Coastal Plain country, the timber marker has to be prepared at any time to leave his marking to control a fire.

Cleaning the gun.—Remove pump and wash pump and tank with kerosene. Clean nozzle by removing and washing parts thoroughly. Do not attempt to disassemble the pump. The single action of the pump prevents any paint from getting into it, so it is only necessary to clean the exterior. Average cleaning time is 20 minutes. Of course in an emergency when changing to the torch, this operation can be done satisfactorily in a few minutes.

Use as a backfiring torch.—In a matter of about 5 minutes the paint can be removed from the can; paint nozzle removed; can filled with 2 gallons of a backfiring mixture one-half gasoline and one-half kerosene; and the backfiring attachment screwed on.

The backfiring attachment consists of a small pipe, a grease fitting for the nozzle, an inner brass tube of Indian fire can trombone type pump, ordinary wicking, and two clamps.

Operation of backfiring torch.—Operation is the same as for the paint gun except for the use of a fuel mixed half and half, gasoline and kerosene. First moisten wicking with fuel. After initial wetting, the wick will stay wet with fuel thus providing a constant pilot light. Two gallons of fuel, conservatively used will backfire 2 miles of line. This torch gives a maximum of burning fuel to the area to be burned, and with the air-forced stream of live fuel, it is possible to set areas up to 15 feet from the operator. The torch will not be manufactured and used until its safety is assured by a competent testing authority.



Wells' combination with backfiring torch attachment: *A*, Small pipe; *B*, grease fitting for nozzle; *C*, inner brass tube of Indian fire can trombone type pump; *D*, ordinary wicking; *E*, clamps; *F*, spray valve; *G*, back-pack can straps; *H*, air pump; *I*, air-vent screw.

Backfiring torch in operation.

FOG MOP-UP NOZZLES

A. B. Everts

Forester, Snoqualmie National Forest, U. S. Forest Service

Many different types of fog nozzles varying from high to low pressure and from 5 to 54 gallons per minute water consumption are finding favor with forest fire fighting services throughout the country. The Navy all-purpose fog nozzle pictured herein is of the low-pressure type operating at 100 pounds' pressure and using 54 gallons of water per minute. The nozzle is composed of two parts:

(*a*) A bronze nozzle with a handle that can be moved to a shut-off, open, or fog position. When in the open position a straight stream is secured. When in the fog position with the fog disk inserted (shown hanging from chain) a high-velocity homogeneous fog with a projection range of 25 feet is produced.

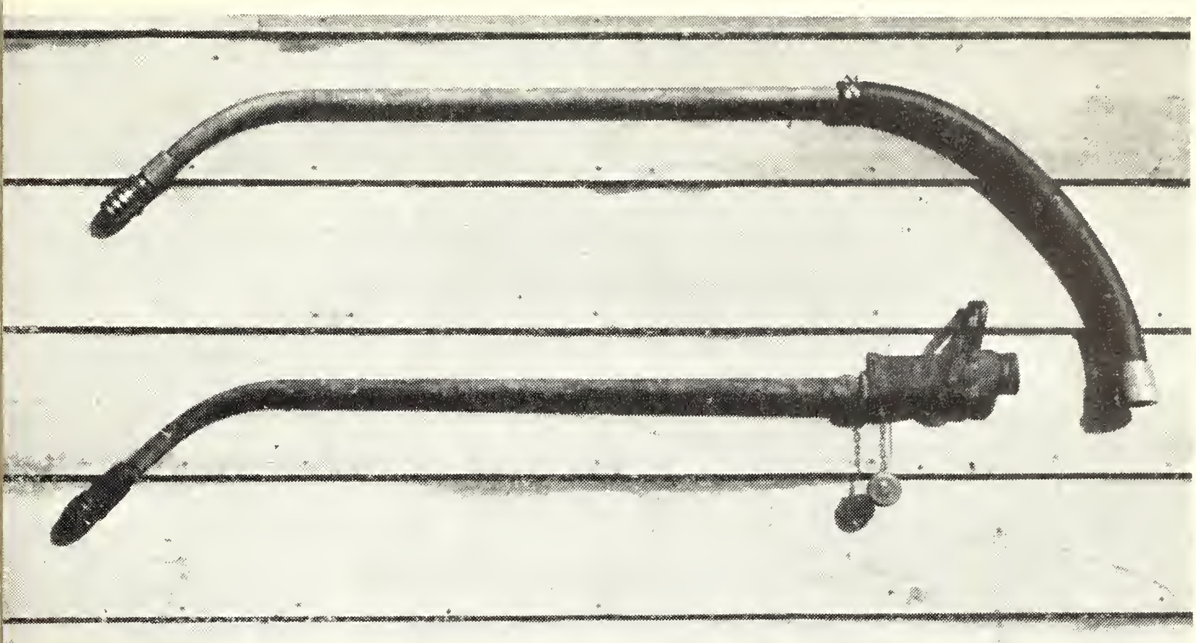
(*b*) A pipe applicator which can be inserted into the bronze nozzle as pictured. The fog tip on the applicator is of the low-velocity type which produces a ball-shaped fog design approximately 16 feet in diameter. It has considerable less projection range than that produced by the high-velocity tip.

Since both of these tips use 54 gallons per minute they are limited for use with low-capacity tank trucks where water conservation is an item to be considered. It has been pretty well established that the efficiency of a fog nozzle is in direct relationship to the amount of water being fogged. Large gallon per minute delivery fog nozzles are, therefore, most useful on pump shows and gravity lines.

This Forest is satisfied that the pipe applicator is about the most efficient mop-up nozzle ever employed. The fog is produced by external impingement, that is, the fog tip is so designed that there are a number of small streams under equal pressure striking each other at right angles. The impact of the streams breaks the water up into fog. There are no moving parts in either of the fog tips, as is the case with the high-pressure fog nozzles. Thus the applicator can be rammed into the deep duff and fuels common to the Pacific Northwest without danger of plugging the tip. Deep-seated burning material around stumps and under logs can be extinguished quickly and efficiently.

Using the applicator with the bronze shut-off nozzle, however, has two drawbacks. The first is that the combination is heavy and tiresome to use for long periods, and the second is there is a tendency for the hose to kink at the nozzle, especially when linen hose is used.

As the result of experience on the East Creek fire, Ross Files of this Forest suggested the improvement shown in the upper nozzle. An 18-inch length of hard rubber hose was clamped to the applicator. At the other end a 1½-inch female coupling is provided for attaching direct to the hose line. This arrangement prevents kinking and reduces the weight from 13 pounds (lower nozzle) to 6 pounds (upper nozzle).



Lower, Navy all-purpose fog nozzle with pipe applicator attached. Upper, an 18-inch section of hard rubber hose replaces the bronze nozzle, to decrease weight 7 pounds and to overcome the troublesome hose-kinking tendency.

TWO-WHEEL MESS TRAILER

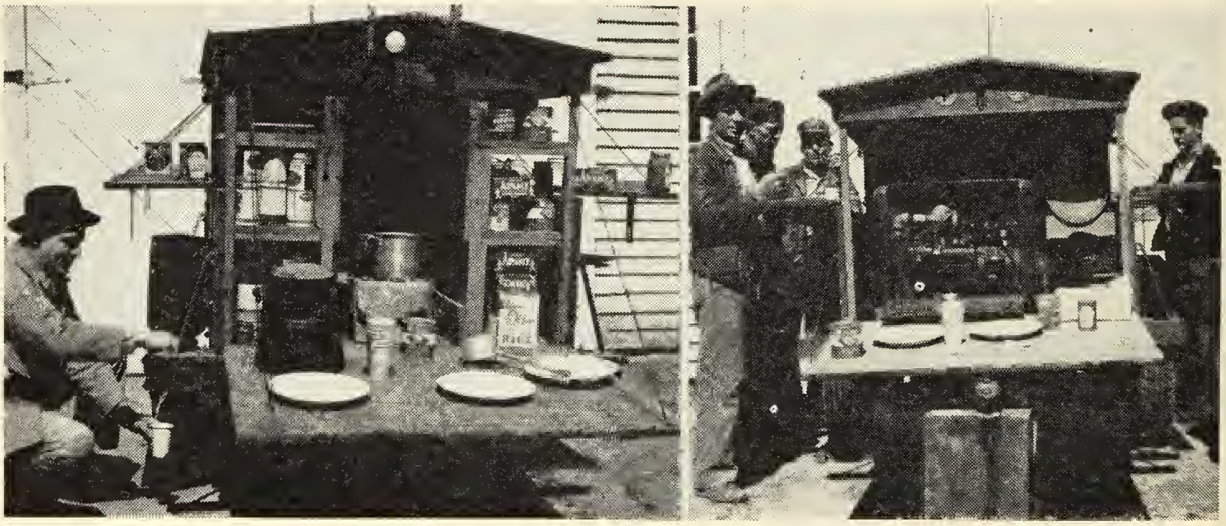
JOHN W. COOPER

Division of Fire Control, R–8, U. S. Forest Service

Many plans and styles of camping trailer and mess truck outfits have been designed throughout the country and all with certain advantages for particular conditions. The Francis Marion two-wheel mess trailer, designed by Improvement Foreman R. N. Strickland on the Francis Marion National Forest, is offered herein as being highly adaptable for immediate dispatch of sufficient food for 100 men for 1 meal or for 40 men for 1 day.

The trailer is light enough to be towed by a one-half-ton pick-up or passenger car, and can be equipped with a standard trailer hitch so that any truck on the district can hook to it and take off immediately for the fire. Two cast iron grills are carried to serve as a stove, and the trailer is always kept loaded with canned and staple food items, cooking utensils, plates, cups, etc., so that it is literally a camp on wheels. Its 40-gallon drinking water tank is a handy convenience.

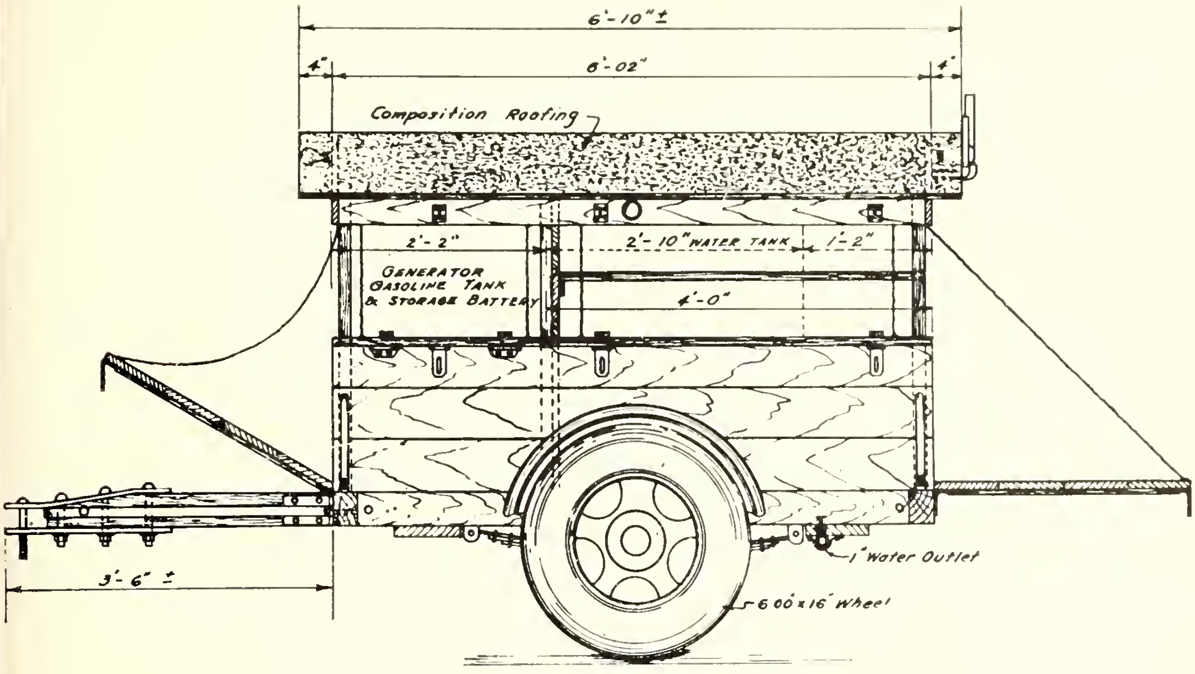
The trailer carries a 1½-kilowatt gasoline light plant and 100 feet or more of extension cord to be used for lighting the camp area. Sockets are available on all four sides of the trailer to make light for the cook. The use of yellow bulbs repels insects.



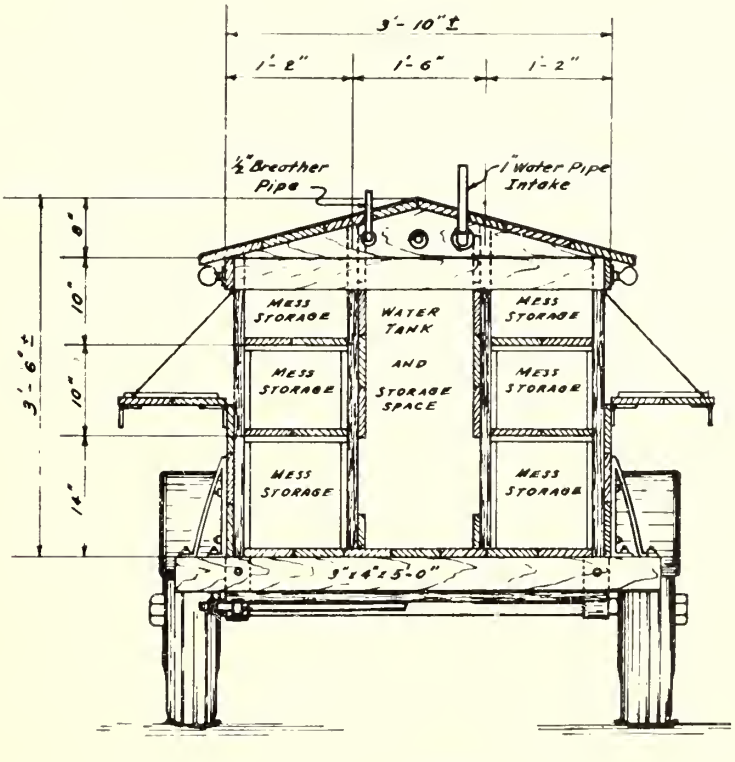
Mess trailer showing: Left end and side gates from rear and Ranger Koen drawing a cup of water; right, front gate, trailer hitch, and light plant.

Among the advantages of this trailer are: The accessible storage of food; the convenient front and rear drop gates that serve as work tables for the cook, and the side drop gates that serve as shelves; simple economic local construction; and the availability of mess gear without tying up a truck.

Construction details are shown in the drawing, which is available by requisition from Region 8 (drawing M–4301).



SIDE VIEW



REAR VIEW

The Francis Marion mess trailer.

Commercial Tackers Facilitate Fire Sign Posting.—Ranger E. A. Hanson of the Toiyabe Forest, tired and a little disgusted with bruised fingers and the job of removing Indian fakir beds of nails and carpet tacks every year from sign backs, looked around for something better than the conventional hammer and carpet tacks. He found it in an automatic tacker using quarter-inch staples. One such outfit costs about $5. Hanson estimates a timesaving of approximately 50 percent per sign and states he is getting a much neater job of sign posting. These tackers are in wide use by business firms, express companies, theaters, and others and can be readily obtained. Rangers having a heavy annual sign posting program may well welcome something like this.—E. A. Hanson, *District Ranger, Toiyabe National Forest.*

FOREST FIRE FIGHTERS SERVICE IN INDIANA

Joseph S. DeYoung

Division of Forestry, Department of Conservation, Indiana

At the beginning of World War II, the fire control problem in Indiana was serious. Many key men, the real "smoke eaters," had joined the armed forces. What manpower would be available to combat forest fires?

In 1942 the Forest Fire Fighters Service (FFFS) was organized in Indiana as a wartime agency. The National Coordinator appointed a State coordinator and an assistant. These were responsible for the organization, publicity, and training work in the State.

At first among the adult groups the progress was very slow. Later the idea of enrolling volunteer members from the Indiana high schools was presented. This proved to be the right move in the development of the Forest Fire Fighters Service.

During the war, the high school students patriotically volunteered their services to help out in the war effort. But how could this work be carried on when the war period ended?

This was made possible by the carefully planned ground work in 1942 when the program started. The school officials, especially in southern Indiana, saw the possibilities of a good conservation training program in the schools. County superintendents, high school principals, civic organizations, conservation club officers, county agricultural agents, and leaders of rural youth groups helped put the program over in their communities. Publicity by newspaper editors and radio broadcasts also helped to get the work before the public.

Just before the expiration of Civilian Defense, July 1, 1945, Gov. Ralph F. Gates wrote a letter to the State forester, a part of which reads as follows: "It has come to my attention that you have done creditable work along the line of training volunteer fire fighters. I would certainly appreciate your going ahead with whatever work you feel essential along this line."

To July 1, 1945, training had been given to boys at 200 high schools in 35 counties, as well as to 1,000 Boy Scouts, 700 adults and 350 high school girls. This made a total of 12,000 volunteers trained. Also 8,000 man-hours were spent combating 238 fires which burned 19,000 acres.

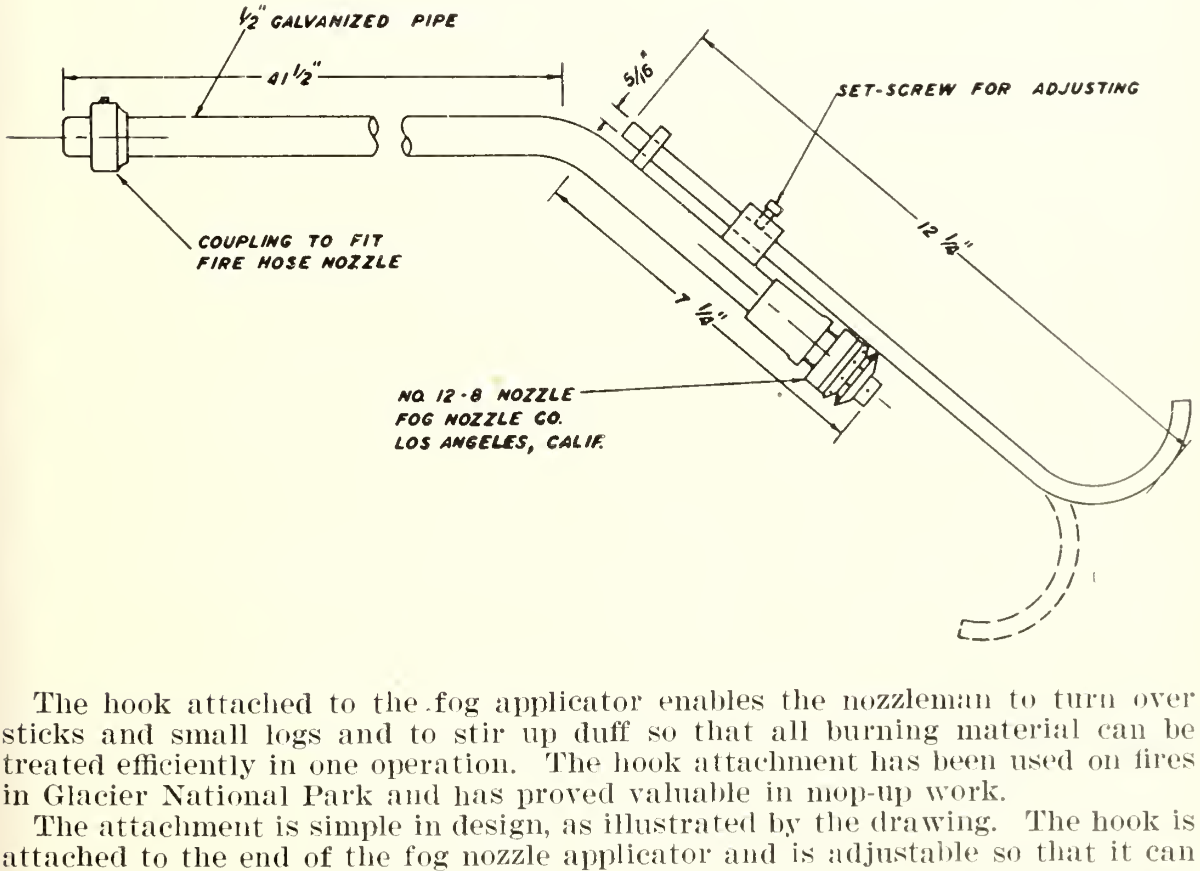
Considerable progress has been made by the Forest Fire Fighters Service. During the period July 1, 1945, to January 1, 1947, training has been given in 100 high schools located in 26 different counties. Five thousand volunteers have been trained, including 3,000 high school boys and girls, 1,400 Boy Scouts, and 500 adults. This makes a total of 17,000 volunteer fire fighters trained to the first of the year. Also 2,000 man-hours were spent combating 100 fires which burned 6,000 acres.

A certificate of merit is awarded to each high school or adult group for their services in suppressing forest fires. There have been 71 awards presented to high schools, and 3 to adult groups since 1942.

Plans have been made to continue and develop the Forest Fire Fighters Service in Indiana by extending the fire training into other counties, appointing additional local coordinators, making new training charts and a fire fighting film, and continuing the contact and follow-up work being done by the fire control personnel of the Division of Forestry, Department of Conservation.

Cooperation by Hoosier conservationists, a thorough and interesting training course given by our training officers, friendly relations with all school officials, and the increased interest in conservation over the whole State of Indiana have all played a part in fostering the continued enthusiasm being shown by students and adults in the FFFS program.

Fog Nozzle Hook.—Fog nozzles have been used effectively in suppressing grass fires and checking spread of certain types of forest fires. In using fog nozzles for forest fire mop-up, however, the effectiveness of this type of nozzle is limited. Most of the cooling action is on the surface and ordinarily it is impossible to reach deep burning fires with a minimum amount of water. The fog nozzle hook was devised to overcome this limitation.



The hook attached to the fog applicator enables the nozzleman to turn over sticks and small logs and to stir up duff so that all burning material can be treated efficiently in one operation. The hook attachment has been used on fires in Glacier National Park and has proved valuable in mop-up work.

The attachment is simple in design, as illustrated by the drawing. The hook is attached to the end of the fog nozzle applicator and is adjustable so that it can be extended or retracted or turned up or down. The five-sixteenth-inch metal rod is heavy enough to withstand fairly rough usage and as much lifting and straining as the applicator itself will stand. The hook also serves as a guard for the nozzle tip.—M. E. SULLIVAN, *Foreman, Glacier National Park.*

THE GILA SMOKE JUMPERS

Don Beck

Southwestern Region, U. S. Forest Service

As an experiment in fire control technique a squad of eight parachute jumpers and one pilot and plane were secured from Regions 1 and 6 for the period May 27 to June 27 for smoke jumping in the Gila Wilderness Area in southern New Mexico. This was the first time smoke jumpers were ever used on fire control in the Southwest.

The wilderness area has rough terrain with altitudes which vary from 5,000 to well over 10,000 feet. An emergency landing strip was constructed near Mogollon at an altitude of 8,500 feet. The higher altitudes and strong air currents created by desert heat were given consideration in planning the action part of the project.

The jumpers were based at Deming, N. Mex., at a former Army air base through the cooperation of the local city officials who had acquired the facilities. Hangar, shop, barracks, and baths were made available. Deming is located within 50 minutes' flight time of the heart of the 800,000-acre wilderness area.

The men and plane arrived on schedule May 27. Between that date and June 27 the jumpers went out on eight fires. At least three of these fires, in all probability, would have reached large acreage and would have been very expensive to control. There is no doubt in the minds of Region 3 personnel that the project proved its value.

During the period of operation all regular ground forces were on duty. On six of the eight fires the jumpers arrived prior to the ground forces and were primarily responsible for control of the fires. Competition was consistently keen between ground and aerial personnel.

At the conclusion of the project results were analyzed and Region 3 believes they can justify an even larger parachute force next season for a longer period. The Region is sure a 12-man group of jumpers based at Deming and used over a 150-mile radius for a period of 2 months will more than pay its way in reduced damage and other fire costs.

One of the interesting portions of the project was the narrative report made by the jumpers on their return to base. The following report covering a single jump and fire was made by Emil M. Reidys, a boy who likes to jump and who comes from Flagstaff, Ariz. It may be of interest to readers of Fire Control Notes.

"*Rocky Canyon fire—June 15, 1947.*

"Preparations were made for a routine patrol; take-off time was about 9:40. After flying along uneventfully for a short while, a wisp of smoke was spotted—the aircraft circled the area. After our pilot had determined exact location by wireless and oriented the area, the decision was made to jump. In order to determine wind-drift, a drift-chute was dropped—as is invariably the case in all these operations. I left the ship at 10:40—exit and opening shock, normal. Rate of descent increased as I neared the ground—violent oscillation set in and a sudden down-draft had me in its grasp. The ominous crunching of wood and breath catching sound of rending nylon blended into one as my 'chute caught and held in the top of the tree. The canopy collapsed, the tree broke, and I obeyed the law of gravity—fell 20 feet and landed on point of left heel. The fire packs were dropped just above me on the ridge—my partner joined me and retrieved the tools—the wind favored us. After working 3 hours on the fire my foot gave out on me. The first smokechaser arrived on the scene about 2:40 and assisted on the fire. Baurer, my partner, set up the wireless and contacted Mimbres Ranger Station. Thereafter contact was maintained every hour on the hour till 6 p. m. The fire was under control at 3 p. m. The packer arrived around 5 p. m. Preparations were made to evacuate. We left the scene of the fire at 6:45 p. m. Two men were left to mop up. We arrived at the Mimbres Ranger Station about 6:30 a. m., Monday morning.

"Aside from inconvenience to other members of the group, due to my slight injury, everything went smoothly. After checking with the doctor at Silver City, we checked in to Deming Air Base at approximately 4:40 p. m., Monday, June 16."

(Signed) EMIL M. REIDYS,
June 24, 1947.

Comment.—"Outstanding above all else is the time element involved in all airborne operations. The sequence of events that follow after a jumper leaves the aircraft is, with a few exceptions, standard operating procedure. From a personal viewpoint of all men involved, it is a job one has to like in order to execute the assignment."

THE USE OF A WETTING AGENT ON A FOREST FIRE

Edward Ritter

Region 7, U. S. Forest Service

Comprehensive tests of wetting agents are planned. In the meantime experience of field men in trials like this are valuable and can speed up the full utilization of advantages that detergents may contribute.

Through the cooperation of State Forester Jacobson and Ranger Edson of the Rhode Island Forest Service, some interesting information was gathered on the use of a wetting agent in the control and mop-up of a spring fire.

On April 11, 1947, an accidental fire started at 12:20 p. m. on Division Street in the town of West Greenwich, central Rhode Island. It was picked up by the Pine Tower at 12:28 p. m. and a crew immediately dispatched, the first men and equipment arriving at 12:50 p. m. The wind was very strong at the scene of fire although the nearest fire weather station some 15 miles away indicated only a class 3 day. A strong southwest wind was recorded by the United States Weather Bureau station at the Hillsgrove Airport about 10 miles south of fire. Velocities at 10 a. m., 12 noon, 2 p. m., and 4 p. m. were recorded as 26, 27, 31, and 25 miles per hour respectively, with gusts recorded as 35, 37, 42, and 32 miles per hour.

The fire originated in a grassy field and blew across a 24-foot black top road into a slash area which had been cut over during the winter of 1945-46, the remaining stand consisting mainly of small scrub oak, pitch and white pine with a heavy accumulation of brush on the ground. The fire crowned heavily in the remaining trees but dropped to the ground and burned into stumps, duff, and brush piles.

The head of fire was controlled with backfire while the west flank was knocked down with water along the edge of a county road. In order to save time, additional cost, and burned area, it was decided to flank the east side without aid of a fire line, rather than to drop back to an old woods road and burn out, which would have increased the burned area by a third.

Twelve hundred feet of fire edge was completely extinguished by approximately 400 of the 600 gallons of water with a 1 percent solution of wetting agent carried in a fire truck with booster pump. The fire was burning in medium to heavy pine slash, some windrowed and some in piles. Many stumps were on fire. No brushing out was done.

Two hundred gallons of "wet water" from the aforementioned fire truck was used in 20 back-pack pumps in extinguishing the 50 or more spot fires which occurred. A second fire truck with a load of 450 gallons of "wet water" was used in mopping up for a width of 250 feet along the entire 1,200 feet of fire edge plus an additional stretch of 1,500 feet at the head and other sectors needing attention.

The ranger was not convinced that the fire was safe or out after the corral and mop-up had been completed 6 hours later so he left a patrolman for an additional 4 hours. No evidence of a holdover fire was noted later where the wetting agent had been used.

There is little point in attempting to show a saving in cost of suppression because of the many variables involved although it is believed a considerable saving in mop-up time might be apparent if figures were analyzed. It does suggest certain possibilities in control without the use of a raked, dug, or plowed fire line. Where the local practice by State or town warden crews does not emphasize line-building in control or mop-up, the use of a wetting agent should be most helpful in keeping burned area to a minimum. Incidentally, the fire described reached a size of 35 acres. Three wardens and thirty-two crewmen were used on the fire in addition to the two fire trucks. Total cost of fire was $137.30. Damage was estimated at $10 per acre or a total of $350.

On April 30, 1947, the effect of a wetting agent in the conservation of water on short lengths of unlined linen hose was demonstrated. By attempting to pump untreated water through 200 feet of dry hose at approximately 100 pounds pressure per square inch, it was found that the loss was so great due to leakage that the 40 gallons used failed to reach the nozzle, while the same quantity of water with a 1 percent solution of a wetting agent reached the nozzle end and 15 gallons came through with considerable force. No predictions will be wagered as to results with use of more water and longer lines of hose, greater pressures, etc. It is interesting to note, however, that there was no apparent difference in loss of liquids in a similar test with the use of mildew-treated forestry linen hose.

Modifying the Trapper Nelson Pack Board.—The following suggestion for modifying the Trapper Nelson pack board may be of some value to those who find frequent occasion to use it. Although I find it more comfortable for heavy loads than any other I have tried, including the Army frame pack, it has one serious drawback. It is poorly suited to use off trails, or on narrow, poorly cleared trails through heavy brush or undergrowth. The upper and lower ends of the frame supports catch constantly in the brush, throwing the wearer off balance, causing an excessive waste of energy, and materially slowing down progress.

By sawing off the upper and lower ends of the supports flush with the pack bag and by shortening the metal pack pins correspondingly, the above inconveniences should practically be eliminated. The loss of the extra lengths on which to hang rope or other odd items will, I believe, be more than offset by the advantages wherever any considerable amount of back-packing has to be done through heavy brush. Bernard Frank, *Washington Office, U. S. Forest Service.*

PLYWOOD WATER TANK

H. C. Buckingham

State Forester, Maryland

During the War when many kinds of metal were difficult to obtain because of the needs of the armed forces, forestry services were hard pressed for suitable water tanks to be used on forest fire patrol trucks. Many fire control agencies use ½- or ¾-ton pick-up trucks as the first striking units in forest-fire fighting. One such truck used by the State of Maryland is equipped with a fan-belt rotary-type pump, a 75-gallon water tank, 300 feet of ¾-inch rubber garden hose, a supply of hand tools for 6 to 10 men, and two-way FM radio.

Since corrosion-resistant metal was not obtainable, Maryland experimented with 50-gallon steel drums, cut-down fuel oil drums, and so forth. Finally at the suggestion of Senior Forest Supervisor Paul H. Seward, a waterproof plywood tank was constructed. This pilot model met the needs—rust free, watertight, shakeproof, easily installed, easy to construct, and economical.

The standard tank adopted is 47 inches long (the width of the pick-up body), 26 inches high (the distance from the floor to the bottom of the rear glass), and 19 inches wide. The reason for the narrow width is to permit the installation of a tool box behind the tank long enough to accommodate a standard fire rake. The ends, top, and bottom of the tank are of 1-inch waterproof plywood and the sides of ¾-inch waterproof plywood. One baffle was installed to prevent bulging and to reduce shifting of the load. The plywood was fastened to a 1½-inch frame of white oak with marine glue and galvanized screws set about 2 inches apart. In assembling the tank the top was put on last. This was to permit wiping excess glue, which would clog the pump, from all inside joints.

A 2-inch flange was used as an inlet in the center of the top of the tank. A 1-inch flange was placed on one end and a hole drilled through the pick-up body to permit a 1-inch pipe connection to a three-way cock installed on the side from which hose lines were taken to the pump.

The materials costs between $20 and $22. Two men can build a tank a day. Regular forest guards are assigned this work on wet days. An 18-gage stainless-steel tank of the same outside dimensions holds approximately 100 gallons or about a third more. It costs, however, about $92, or more than four times the cost of a plywood tank, disregarding contributed time of guards.

So far no tank has been discarded because of structural failures—none has warped, twisted, or opened at the seams. Once on the way to a fire, a truck upset and the tank, half full of water, was tossed several feet. After the truck was righted, the tank was replaced and used on the fire. No leakage resulted.

The only drawbacks to this tank are the volume of space used by the plywood and frame, and the fact that eventually the tanks become waterlogged and gain considerable weight. Experiments with thinner plywood to reduce weight and increase capacity are now being made.

SLASH DISPOSAL IN SELECTIVE CUT PONDEROSA PINE STANDS

MERLE S. LOWDEN

Forest Supervisor, Fremont National Forest, U. S. Forest Service

Slash disposal is big business. As millions of acres of timberland are cut over in this country each year foresters, loggers, lumbermen, land owners and others are concerned that the hazard created in logging receives proper attention. An important requirement in changing virgin stands to managed forests is to keep protection costs in the cut-overs at a low figure. Costs of protection should be as low as is reasonably possible if forestry is to be profitable. The amount and type of hazard reduction done after cutting has a vital effect on these protection costs. There will likely always be two schools of thought as to the amount of effort that should be put into hazard reduction and that which should be devoted to extra protection. The ramifications of that argument are many. Regardless of the good points put forward by the "extra-protectionists" there still seems to be a place in protection for disposal of some slash. The insurance against large fires which prepared fire-breaks give cannot be completely depreciated.

Much of the cutting in ponderosa pine stands is now by tree selection with 30 to 70 percent of the stand volume removed. Adequate treatment of the slash hazard in this cutting presents many problems in both technology and economics. Study and experimentation in new and different methods may bring dividends far above their cost.

In carrying out a $60,000 annual business in hazard reduction on the Fremont National Forest during recent years our men have tried to devise new methods, practice economies, improve practices and in every way get the most in future protection from every dollar spent. Many of our ideas are not new. We've copied or adapted devices of others that looked good to us. Many foresters on other Federal, State, or private protection units likely have developed methods in advance of ours or at least ones they strongly advocate. Because we have had a large job of a particular type it seemed that our methods might be of interest to others.

Our aim in slash piling has been to establish prepared firebreaks along roads or otherwise at not too widely spaced intervals from which to backfire. In doing this we pile about 10 percent of the total cutover area. We don't expect to prevent fires by piling and burning slash but we do hope to reduce the burned acreage.

Planning the Job

We consider careful planning to be most important in all hazard reduction work. Planning means a visualization of the desired product and then setting up step by step procedures to get this product. Planning starts with a good base map of the forest area to be cut.

Our maps for "rushed" wartime cutting were not as good as we wanted. Logging plans are easier to make with a good map. A good base becomes the foundation for road plans, cutting progress maps, hazard plans, and future detailed fire control maps.

From the logging plan on a good base map an appraisal of the hazard reduction job can be made. This is necessary in most of our national forest timber sales where an advance cooperative deposit is taken to cover slash disposal. Such deposits have varied from 25 to 40 cents per 1,000 board feet of timber cut. The exact amount is based on an appraisal of the work needed.

Our hazard reduction plans are of two types: the over-all plan for a unit and the detailed plan for an individual project. An over-all plan may be for a unit as large as one or several townships. Project plans are usually for the work one crew will do in a season or a contractor will do in a reasonable time of possibly 1 to 3 months. The over-all plan consists of a map showing all roads and firebreaks on which slash is to be piled with such explanatory material as necessary to make the map clear. The plan outlines whether contractors or hired crews are to do the work, whether machine or hand methods are to be used and when the work is to be done.

Project plans consist of a plan map, narrative instructions covering specifications of the job, who is to do the work, when it is to be done, and a financial plan or budget. A short statement covers the extra protection planned for the area until the hazard is appreciably reduced.

Early in planning it is necessary to determine who will do the slash job, the operator or the Forest Service. Several years ago this work was usually assigned to the operator by the terms of his contract. We have gradually quit this practice. Now practically all our slash is covered by cooperative deposits and the work is done by our crews or is contracted. Where the operator did the work it was necessary to write careful specifications for the job. The work required close supervision and there was likelihood of misunderstanding. There are many advantages to the cooperative deposit method such as flexibility of funds, assurance of getting the exact type of work desired, having available labor to do other project work which is not of sufficient amount to support a crew, and the value of supplying off-season work for protection personnel.

Road construction slash is a particularly perplexing problem. Our former practice was to have the operator care for such slash. This did not always prove satisfactory. There is a likelihood of misunderstanding when the logging operator handles the construction slash and the Forest Service handles the logging slash. If road clearing is done well in advance of grading as should be done, the operator can pile the road debris without interfering with later work on logging slash. There are strong arguments for requiring logging operators to do this and if it is their responsibility unnecessary "pushover" tree messes are not likely to occur.

Snag Felling

An important part of the hazard reduction job is felling snags along roads, in other critical locations, and on firebreak strips. Snags not only are bad to scatter fire and hasten its spread but if not felled are there to come down later and block roads. Location of the snags to be felled is an important part of the hazard plan. Our practice has been to fell all snags that would reach or that are within 100 feet of roads or bulldozed firelines to be piled. In addition, critical snags along ridge tops, around recreation or other public-used areas are felled. Practice has varied on different cutting areas as to whether we or the operator did the felling. Through the period of employment shortages in the war years the usual practice has been operator felling. They had trained fallers on the job and could get the required work done. Performance bonds assured that the required snags would be felled.

Many methods of snag felling have been used with varied success. As in felling green timber there doesn't appear to be a great saving in costs of machine felling over the hand method but it does take less men. Burning down is quite successful for many snags, particularly those referred to as "buckskins" and any with large cracks or pitch bleeding. Machine pushing works well in light soils, particularly those of the pumice type in the north end of our forest. Our largest operator there has pushed over snags along hundreds of miles of road during the last few years. There is need for more study on comparative costs for the various methods of snag felling. Present figures point to pushing on light soils, burning those that burn easily on heavy soils, and machine felling the balance. Burning with "goop" offers good possibilities and so far is working out well. It is being given a thorough trial to determine the best methods of use.

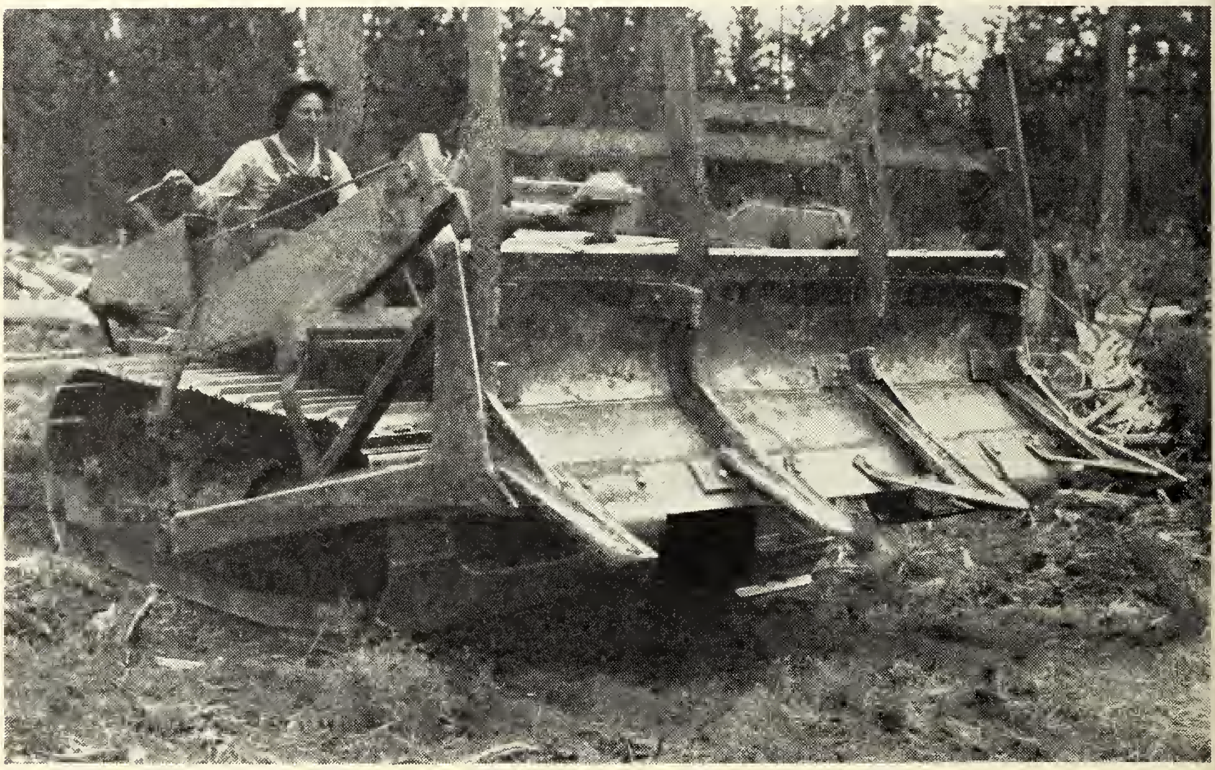
Managing the Slash Job

Each of our district rangers is directly in charge of the disposal job on his district. He prepares the work plans and financial budgets. These are approved by the forest supervisor and then placed in execution by the ranger. If it is a contract job, he has charge of preparing bid maps, staking the area in the field, and inspecting the contractor's work. On one district where the job is particularly large a project foreman supervises slash disposal work under the general supervision of the ranger. Timber sales personnel may assist in some details but we have found it best not to interrupt their primary timber work. Financial control is maintained through a project budget prepared by the ranger and approved by the supervisor. This sets up an allowance of man-days, mileage, supplies, and other predetermined expenses. Record of the progress of work is maintained by the foreman on his plan map and by the ranger for all projects on a district map. For a large unit on which several contractors are working, a map is prepared showing each contract in a different color. Progress is kept by putting a wavy line over the planned work line.

Slash Piling Methods

Methods of slash piling have changed greatly on this forest in recent years. The work was formerly done entirely by hand with hired crews. As wartime employment problems increased and the quality of available help decreased, contracting by the acre was encouraged. The bulk of our work is now done in this manner. Detailed specifications for piling are included in the bid requirements.

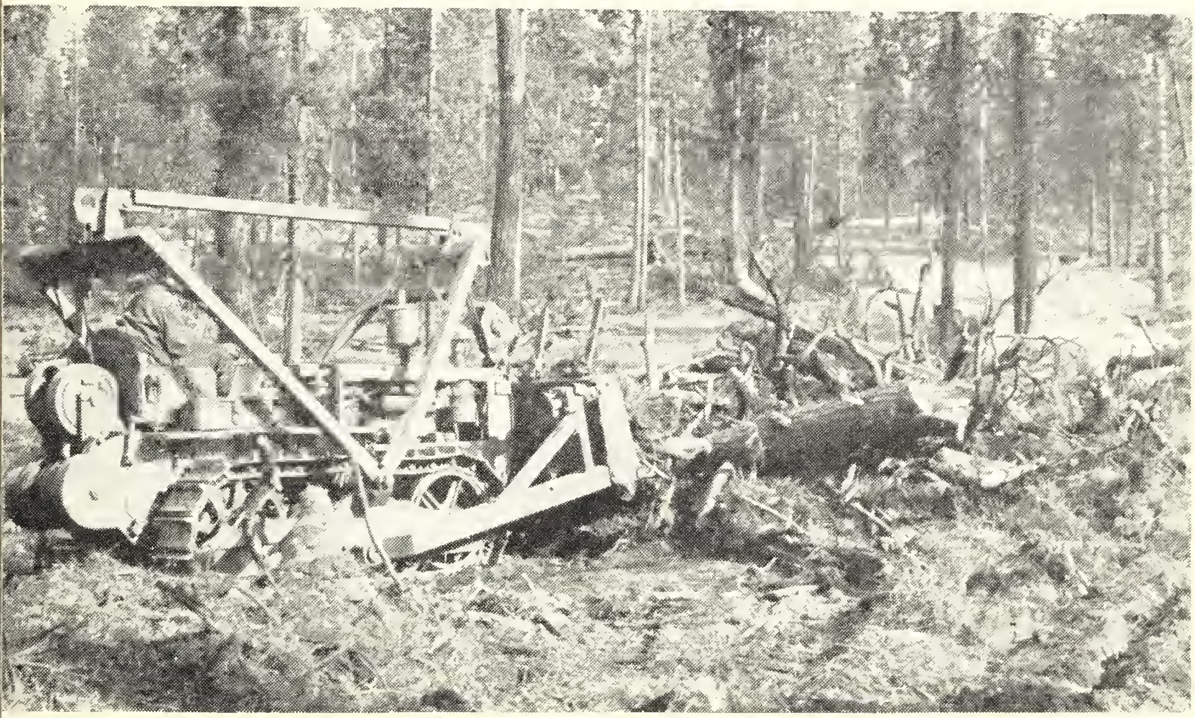
Hand piling has followed conventional methods except we have tried to take advantage of existing logs, uprooted snags and slash concentrations and to pile on them. Supervision of employed crews and close inspection of contractors is important. The real test of whether piling is good or bad comes when the piles are burned. Loose piles wet through quickly and after heavy rains or snowfall are hard to burn. Roughly a pile that can be seen through is too loose. We have tried to get the piling and burning done by the same persons but that has proven difficult. Contract pilers are often itinerants or at least want their money soon. They can't wait for it until the burning season. Sometimes we have been able to hire them later for burning work and usually it means better future piling. After a man has tried to burn wet loose slash he makes better piles. Hired crews have been mainly students and they are gone when the burning season arrives. The period when successful swamper burning can be done is short.



D–4 tractor equipped with slash-piling teeth on bulldozer blade. Note heavy shoe under blade which prevents teeth from digging in ground. Designed by private contractor working on Forest Service contracts.

In 1944 considerable experimenting was done with machine piling and this work readily sold itself. Different tractors were fitted with a variety of special teeth on the dozer blade until what seemed to be the correct set-up was worked out. Employment of operators at Government pay for this job proved difficult so other means were tried out. A local tractor owner was persuaded to equip his D–4 Caterpillar with the special teeth and try a contract. He did one contract and was anxious for more. This procedure is now well established and we have been very gratified with results.

Machine piling in general does many things in a better way than hand piling. It gets all the heavy fuels such as logs, large limbs, and uprooted stumps into the piles to be burned. Piles are larger and can be put in openings. There should be less damage in burning. With a little care on the part of an experienced operator there need be but little damage to reproduction or valuable browse plants. Our machine-made piles have burned well. At the same time it has proven to be a cheaper method per acre. For 1945 and 1946 machine piling has cost us from $9.50 to $10.50 per acre with an average of $10.20. Hand piling in the same period has varied from $8 to $14 per acre with an average of $11.11. These are contract figures. Machine piling with our own operators has run a little less and hand piling with crews a little more than by contracting. Contracting takes less overhead and is a means of accomplishing a job when hired help cannot be obtained. We hope to get more private owners to equip their bulldozers for piling slash and thus get more competition and more available equipment. Machine piling has the added advantage of providing a very good suppression tool where it is likely to be needed during the fire season. After watching the work of various sizes of bulldozers from a small Clarkair to a large D–8 we favor a medium size.



D–4 tractor equipped with slash-piling teeth on bulldozer. Note heavy material being placed in pile.

In our piling along roads or skid trails we usually work 100 feet on each side after the snags have been felled. A set distance aids inspection of contract work and requires less supervision. With our own crews we often vary the strip width to meet hazard and need conditions. Our chief problems beside loose piles are those that are too small or those piled too close to live trees.

The Burning Job

Our burning methods have varied as widely as have our piling procedures. We have tried many types of torches or burning machines, impregnated sawdust and planer shavings, goop, flame throwers and old fashioned methods of kindling. Dryness of slash and weather conditions determine the best device for a particular job. It is difficult to get ideal conditions between the time fire will not spread from burned piles until the piles are too wet or the snow too deep. This time is usually short. When the slash is fairly dry we have found a good hand flame torch utilizing air pressure or the drip torch to be the best. Several types are suitable. Sawdust or planer shavings soaked with a mixture of one-half gasoline and one-half Diesel oil is good on tight piles even though wet by rain or covered with up to 4 inches of snow. We mix the materials in open barrels, pack in buckets and distribute with scoops made from tin cans. This method is better than hand torches on fairly wet material but slower than the torches on drier slash. Goop seems to work best on very wet material or heavy chunk and logs. It is slower than the other two but has a real place when used liberally on large piles, logs, whole trees or any wet material. We've tried several "machine" burners but haven't yet found a fully successful one. With improvements or perhaps other types we have not used they undoubtedly have a real place in slash burning.

Immobility, initial cost, fuel cost, and mechanical faults have been the chief drawbacks to those we have used. With further development they will likely gain in favor. There is a large field for experimentation with a cheap, easily used chemical burner on the order of a fusee but more powerful and longer burning.

We have a burning plan for each district and try to hit the job hard when conditions are right. Fortune smiled on us in 1946 and we got nearly 100 percent of our piling burned. On one district the crews burned 87 miles piled on both sides of roads or plowed lanes in 1945 and 59 miles in 1946.

Other Measures

Following logging we try to get all roads signed as soon as possible. Many of our large areas are a maze of roads which would baffle a taxicab driver. We name main roads and sign them with termini and distances. On other roads we use a numbering system from 1 to 100 or more. Units distinctively separated have a different series of numbers starting at one. Every road junction or takeoff is signed. Road numbers are shown on the detailed fire maps. These maps cover all cut-overs and when completed will cover the entire forest. We have a key map for the forest showing the units covered or to be covered with detailed maps. Besides showing all roads with their name or number the maps show physical features of value as fire control information and the location of prepared firebreaks. Lookouts, firemen, or other personnel working in or near a unit have the map for it.

In planning protection of cut-overs there are of course many other aids that must be considered such as water developments, personnel, equipment, detection, closures, patrols, prevention efforts, roads, and cooperation. But those are other stories.

○

olume 9 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Address DIVISION OF FIRE CONTROL
Forest Service, Washington, D. C.

NITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1947

Contents

Page

ie helicopter—a new factor in fire control 1
Frank J. Jefferson

spatching aids 9
H. S. Palmer

›ving fire posters 10
Alan A. McCready

orida's most modern fire truck 11
Owen R. Douglass

simple binocular holder 12
Edward Ritter

ıwn Patrol 12
Neal M. Rahm

ındamentals of fire behavior 13
H. T. Gisborne

ıfe storage of fire tools 25
R. W. Bower

ı efficient snag pusher 26
R. W. Bower

re fighting de luxe 27
Don Beck

ıking contacts and establishing good will 28
C. H. Coulter

ıgnesium wedges for felling and bucking 33
Walter J. Puhn

ıst prevention for milk cans 33
Fletcher Hayward

ogressive hose-lay in fire suppression 34
Stanley R. Stevenson and Edward W. Schultz

ınnel attachment for 1-quart gasoline can 39
Cleo Anderson

ol box for felling outfit 40
James E. Taylor

ɔam 41
A. B. Everts

ıpport for canvas relay tank 46
Richard Raybould

THE HELICOPTER—A NEW FACTOR IN FIRE CONTROL

Frank J. Jefferson

Assistant Regional Forester, Region 5, U. S. Forest Service

Foresters, in their effort to manage wild land more efficiently, have een continually envious of and wishful for the ability of the bird: travel swiftly; to see rough terrain at close range, but in perspecve; to hover and to alight in small spaces. Who wouldn't want to ake more useful use of time, avoid leg weariness, and bypass the iscomfort of an ill-fitting saddle and a bum horse? In none of the ctivities of a forester does this need assume greater significance than the field of fire control. Small wonder then that some, and espeally those charged with fire control work, have followed with avid terest the development of rotary-winged aircraft during the past lf generation. Here is what they watched:

Developmental History

22—United States Army makes its first helicopter take-off and landing.

29—Autogiro Co. of America formed, produced a rotary-winged machine—used largely in the advertising field.

31—Helicopter reaches height of 500 feet—horizontal speed of 50 miles per hour. (A prospect.)

31—S. A. Nash-Boulden, supervisor of Los Padres National Forest, made partial flight over his forest in autogiro, believed to be first flight by forest officer in rotary-winged craft. Prophesied success.

35—Army Air Corps purchased two autogiros for purpose of laboratory and flight testing. Proved successful for artillery fire direction operations. (Encouragement.)

37—German helicopter reaches elevation of 11,700 feet, speed of 68 miles per hour. (More encouragement.)

38—Army Air Corps starts school for autogiro pilots.

39—Sikorsky develops successful helicopter.

39—Army Air Force switches to helicopter. It is of interest to know that Dave Godwin was Forest Service member of the committee that made this decision.

42—Sikorsky demonstrates helicopter, proves it to be a feasible machine; 5,000-foot elevation, 78 miles per hour. Made 761 mile cross-country trip. Its potential value in fire detection and suppression recognized by staunch advocators.

43—Helicopter used by Army to transport wounded from jungles of Burma to base hospital. (A lift to proponents.)

44—Sikorsky Aircraft now operating helicopter production line.

1944—Lacking facts as to mountainous services, western regions prepare transportation plan based on predicted helicopter transportation probabilities.
1945—Forest Service and Army Air Force in collaboration test use o helicopter in mountainous areas. (Has possibilities wit skillful pilots.)
1946—Helicopter used in a limited way, but successfully, on Castai fire, Angeles Forest. (Punches pulled due to theoretica limitations.)
1947—Helicopter used as key working tool on five major fires in Cal fornia national forests. (Pilots went "all out" to giv service.)

This chronology might lead to conclusion that the course of rotary winged aircraft development and adaptation to the problems of transportation and supply service in mountainous areas was one of smoot sailing. Such was not the case. Many discouragements confronte the inventors and proponents of the machine, as test model after tes model disclosed flaws of mechanical design, displayed impractical idea as to load and elevation limitations, and a myriad of similar disappoin ments. The handful of foresters who, over the long years of its developmental infancy, daringly visioned and voiced their belief in th successful adaptation of the helicopter to forest fire control steadfastl faced skepticism of their co-workers.

Three people (Pat Thompson, Dave Godwin, and Ted Norcross got their dander up. Action started. In 1944 an analytical study wa undertaken of the feasibility and cost of helicopter transportation a compared to costly roads in fire control work on certain selected fores (Circular E–2963). The study, while based on theoretical operatio costs and performance hoped for but not yet attained, served two pu poses: (1) It indicated that helicopter transportation, if it met e pectations, would result in better fire control at lower cost, and (it stimulated interest in the study of the new type of aircraft.

At that time there was little factual information as to the perform ance of these machines under the conditions of wind, topography, an elevations common to the forested land of the West. As a matter cold fact, all conceptions as to mountain performance were speculativ There had been no tests.

Testing for Mountainous Forest Fire Control

Gen. H. H. Arnold, Chief of the Army Air Force, had, from almo the beginning of his career, been deeply interested in the aerial phas of forest fire control. He served as one of the earliest of fire-reconnai sance pilots. This interest in 1945 lead to the Army Air Force and t Forest Service joining in a series of helicopter tests under weste forest conditions, using Air Force "Sikorsky" machines and skill Air Force pilots. The Angeles and San Bernardino Forests we selected as proving grounds for these tests. March Field, inte nationally known and "Hap" Arnold's old command, was the operati base. The tests included, among other things, determination of t allowable pay loads which with machines of the type tested (Sikors R–5) would permit safe landing and take-off under varying conditio of flight distance, altitude, temperature, wind velocity, and weight d ibution. The findings of these tests are reported in the January)47 issue of Fire Control Notes. Significantly, the machines were emonstrated to be (within their limits) feasible working tools for econnaissance, supply and personnel transport under mountain onditions.

In 1947 two privately owned Bell model 47–B helicopters moved into uthern California. Immediately arrangements were made by conact to run these through the same tests as given the Sikorsky maines. Results were satisfactory. A full report of these tests will opear in Fire Control Notes.

The Pay-Off

An Army Force Sikorsky model R–5 was used for reconnaissance id a small amount of supply dropping on the Castaic fire in 1946. did all that it was asked to do, but it worked under the "tight wraps" the test conclusions. Nobody stepped out into the field of "what can e damned thing do?"

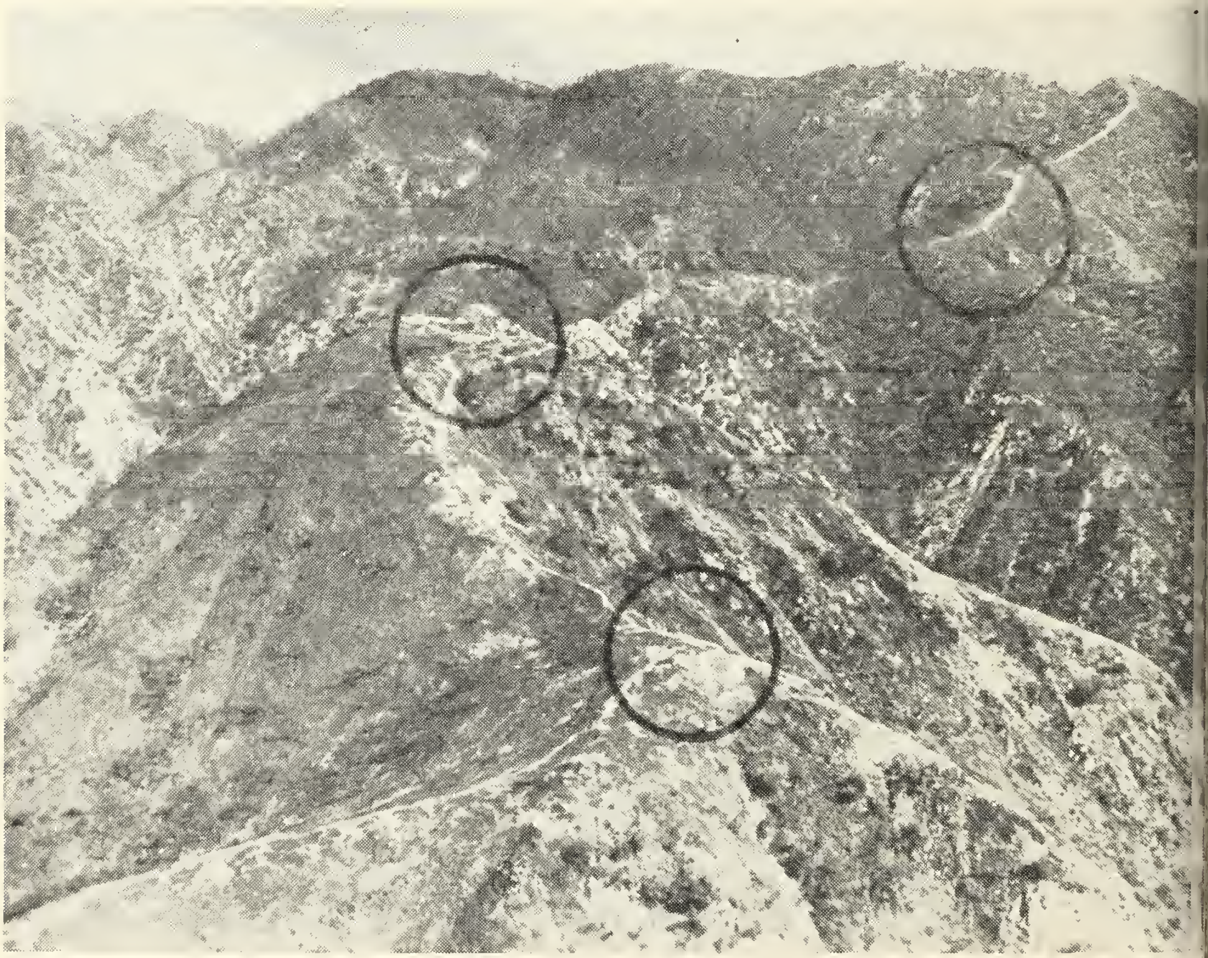
The golden opportunity for a test of positive performance under ying field conditions came with the Bryant fire on August 5, 1947. his fire started in Big Tujunga Canyon of the Angeles Forest, which an area characterized by very high watershed values, considerable ome investments, rapid rate of fire spread, and steep, inaccessible untry. Further, the fire was a direct threat to all of the suburban evelopment on the north side of Los Angeles. The Forest Service as not disposed to leave any possible resource unused. There were ailable the two Bell helicopters owned by the man who had particiated in the earlier tests of the Bell and who was very much interested proving the worth of the helicopter. These were pressed into rvice.

Two of the primary physical factors affecting the performance of licopters which were encountered exceeded substantially the condiions of the earlier test operations. Temperatures were up to 107 derees as compared to the 100-degree temperatures under which the tests ere conducted, and elevations were operated successfully up to 5,400 et as compared to the 3,500-foot elevation which was felt to be about ie upper limit under the test conditions. Wind, a third important ictor affecting the performance of the machine, was, of course, variole but generally exceeded the 0 to 5 miles employed under test onditions. With this set of conditions, and with two helicopters, vo willing, skilled, and courageous pilots, and an experimentally inded fire manager, a fresh chapter in fire suppression history was ritten.

Successful undertakings on the Bryant fire, which were later dupliited on the Cleveland, Eldorado, Mendocino, and Tahoe Forests, stablish the place of the helicopter in fire suppression.

1. The fire boss and his two zone bosses by helicopter personally ivestigated ground conditions, action strength, and fire behavior equiring major decision in strategy and tactics and without delay and ith complete mutual understanding converted strategy to action. It certain that without this coordinated and on-the-line size-up of the tuation the usual lags in action and debating of decisions incident to large fire would have occurred. This complete coordination could

Fire scouted by helicopter. Note ease with which manpower and tool requir ments can be determined.



Typical section of line showing ease of transporting key overhead to critic portions of line.

ot have been attained through use of legs, horses, or cars. The lines ere too long and country too rough to accomplish a complete size-up uickly by orthodox methods.

2. The line boss, responsible for execution of control action in an rea which could be covered once by conventional method in not less han 12 to 14 hours, was able to give on-the-ground (this literally) upervision to division bosses several times during the shift.

3. The Scouting and Plans organization with two flights per day btained more timely information on which to base fire behavior estiates and control force requirements than would have been posble with three to five ground scouts working from daylight to dark.

ote detail with which ground cover can be observed from helicopter for Scouting and Plans organization.

4. The service and supply chief was able to visit secondary bases of peration once each shift and provide the constructive advice so ften lacking to this group in the fire organization. As a result of uch visits, overstocking of supplies was avoided and distribution of carce strategic items on the basis of actual need was assured.

The value of the helicopter in the field of service and supply is furher indicated by these typical incidents:

(*a*) Eighty fresh personnel were placed on one division by heliopter in 3½ minutes per man as against 3½ hours by ground travel. Half of the crew were active on the job in 1¾ hours, compared to the whole worn-out crew in 3½ hours. Absence of fatigue and resultant high morale paid off in the form of at least a doubled rate of line con-

Six skilled fire fighters landed here and were able to hold fire on this ridg
Landing spot 8 by 8 feet, elevation 3,600 feet.

struction. Active action on the line started within 4 minutes afte the first man (the division boss) took off and stepped up progressively from then on. Also, the helicopter and its first passenger bea the proverbial "cock's crow" signal of dawn by a few minutes. Thi may or may not have been risky, but the old red rooster drooped hi tail feathers the rest of the day. This crew was based on the lin (actually) for 1½ days and subsisted with hot meals, lunches, an water from the base camp by helicopter. They finished their assignment in a happy mood.

(*b*) Men were needed, urgently, on a strategic hot spot in a remot and almost inaccessible situation. The first man was on the line 1 minutes after the need was discovered; 1 hour later the sixth ma arrived. The helicopter had found a usable 2 by 4 landing spot. B conventional methods these men would have arrived not less than hours after the need was known, worn-out by hiking, and probabl too late to have been effective.

(*c*) A need developed for additional leaders to direct a snag fellin operation. Plenty of workers, but green hands, were on the line. Th extra leaders required were on the job, by helicopter, within 10 minute

(*d*) Extra saws and felling tools were needed for this job: anoth 7-minute mission for the bellhop of the skies.

(*e*) A truck tipped over, 25 men were injured, 3 seriously; 2 hou by road to the nearest doctor or hospital, 4 hours round trip. Th helicopter had the last of these 3 seriously injured men in the han of a doctor 45 minutes after the accident was reported. Landing sp was on an "out curve" on a 9-foot truck trail.

(*f*) Back-pack pumps and water were urgently needed—2 hours alking time from the nearest road. The first of these was delivered ithin less than 10 minutes after the order was placed.

(*g*) A critical situation requiring extra men, tools, and water eveloped on a sector. Pilot Knute Flint was asked to reconnoiter nd report the nearest available landing spot. Within 5 minutes he as back. His need was a competent smoke chaser, an ax, and a pair f pruning shears. His plan: to hover low over the selected spot; hrow out the tools; the man climb out, let himself down 5 feet, and lear brush clumps off a knoll top. During the clearing interval, 15 inutes, Flint would return for the needed supplies and start delivery. ission was accomplished per schedule, and the sector held. The nding spot was within 3 minutes of the job to be done.

So much for the Bryant fire. When the results of this operation ere summarized, it was found that the grit and skillful service with hich field conditions were met were much more favorable to operation f the helicopter than was anticipated during the testing operations. andings with full load were being made at 5,400 feet. Maybe this as on the dare-devil side, but it worked. Successful fire control has requently had its genesis in dare-devil try.

In the language of the Angeles personnel, the helicopter had "shed s diapers" and had grown up to a full-fledged and effective worker. ollowing this performance the helicopter was used on the Cleveland, ldorado, Mendocino, and Tahoe Forests on similar missions. In very instance the findings on the Bryant Canyon fire were substan-ated, and in some cases exceeded. Tom Bigelow of the Klamath orest, a veteran of 25 years of fire service, says: "After 25 years I ave seen what I have dreamed of—a service that gets me and what need there right now."

On the Allen Ranch fire (Eldorado Forest) the initial landing was ade on the top of a lumber pile. On the Bloody Run fire (Tahoe orest) landing was on a tiny sand bar in a difficult canyon, but a rew was supplied from this base for 2 days. These are accomplish-ents on going fires.

For the future, we believe that if the Forest Service does not embed self in a shell of orthodoxy, including conventional plane service, the eed for a large overhead organization on major fires, with many men erving Supply, Plans, and Line, should be a thing of the past. The stification for these have been the span of control limitations oc-sioned by the travel time between given jobs in the total operation. lanning control of the fire, for example, consists of gathering accurate nd timely information on which behavior and control force require-ents can be based. With one man covering in intimate perspective) to 40 miles of perimeter an hour, there is little need for time-con-ming ground scouting as we have practiced it. In sharp contrast to e limitations of a plane, a helicopter can work with safety just a few eet above the ground cover and follow closely the profile of a fire's erimeter. Its action is precisely that of a vehicle following the ups nd downs of a cross-country road in hilly country. Likewise, due to s ability to work "just above the tree tops," splendid, closely detailed bservation results are had under smoke conditions that make plane bservations or "across the gulch" ground observations wholly useless. 's also "aces" for spot-fire scrutinies. A close down hover or a couple f tight circles at a bad spot gives the answer.

In servicing fire fighters, elaborate secondary camps with the usu primitive and labor-consuming equipment and the temptation to cam at the water hole will go out of the picture. All the services such cooking and tool reconditioning can be performed at a central poi where the best of facilities are available and still accomplish the sa end product—well-fed and well-rested men camped on the line.

Line supervision of control work has to date been territorall assigned on the basis of walking or saddle-horse time to attain t required frequency of supervision. The helicopter can provide th frequency in one-twentieth of the time. This would indicate th when we know how to use the machine one man can adequately supe vise the top line work on any fire situation which we have experience in recent years. His big need will be a stenographer, a radio, and loudspeaker.

The need for division boss caliber supervision is due to the inevitab occurrence of localized critical situations at numerous points along t fire perimeter. With a continuously current observation coupled wi a means for depositing this caliber of man where needed and whe needed, the half-mile "division" that has been necessary in some our more rugged terrain will go out of the picture. Just what this wi add up to in terms of skilled personnel necessary for a specific operati is yet to be determined, but it is a certainty that if Les Covill, To Bigelow, Hi Lyman, Glenn Thompson, and their successors, don't ha to use their legs to move their eyes and brains around they're going be the boss men on a lot longer fire lines.

Interestingly, well over 200 men were transported by helicopter th season with but one objector. To the rest it was as welcome as a tax cab on a rainy day; in fact, several tried to develop hitch-hikes fro line camp to home base. It's a mighty easy way of getting fro hither to yon without getting leg weary.

The Future of Rotary-Wing Aircraft

Today we have the Bell Model 47–B which is a proven working to when combined with sufficient pilot skill. A Sikorsky S–51 is capab of performing our job, but its production is so limited that its ava ability for suppression work is doubtful. What then can we reaso ably expect in the near future? The surprising thing is how much c be accomplished with small capacity machines. We have thought terms of four- and five-place ships. The little fellows have shown the selves to be producers. We can't afford to bypass them. The fact th development work is proceeding so rapidly is one reason that the pre ent models are not being produced in greater numbers. Let's devel with the commercial development, but keep even or a pace ahead it. Obsolescence is a real factor when dealing with a $20,000 to $70,0 piece of equipment. In the hopper at the moment are several differe dual rotor craft that, if they meet claims, will provide an operati ceiling of 13,000 feet with pay loads up to 1,500 pounds. It is qui possible that the smaller type helicopter, which due to size alone is more versatile machine, will be redesigned to permit spot landin and take-off at greatly increased ceilings.

Experts in the field of helicopter design believe the 25- to 30- pa senger machines are well within the realm of possibility, but they a

ing to lack the flexibility of the little fellows that can land on a dime.
d count the big fellows out—they will require too much in the way
f prepared landing spots.

The variety of uses to which the helicopter can be put is far from
ompletely known. For example, more positive water bombing of free
urning fires is a reality. Also, the whipping up of backfires by a
otor-inspired breeze, which was done on the Cleveland, and the re-
rding of a free-burning brush fire by kicking an adverse wind in its
ace, likewise an accomplished fact, open up a lot of speculative
ssibilities.

Let's give this machine the respect that is due, use it, and save a lot
f our successors unresolved questions, achy joints, and sleepless nights.

Conclusion

Foresters cannot afford to overlook the helicopter in any plans for
orest management involving reconnaissance, transportation of per-
onnel, equipment or supply, or special project service, whether they
concerned with fire suppression, timber survey, snow surveys,
nge reseeding, tussock moth control, or road and trail studies. The
elicopter, in good condition and with skillful pilots, while not a
anacea for all our transportation and service problems, is a proven
nplement available for its proper place in the field of wild land
anagement. Let's give it its place in our plans.

Dispatching Aids.—A method for recording data on going fires which should
ove of assistance to dispatchers when lightning storms are in progress is
ggested. A brief discussion of the proposal follows:

1. Cover the regular forest map of the area being affected by the electrical
orm with plexiglass sheet and secure it to map with scotch tape.

2. Indicate on plexiglass by previously determined symbols—

(*a*) Location of each lightning strike likely to result in a fire.

(*b*) Time of discovery for each fire as reported by the lookout or lookouts.

(*c*) Rainfall showing whether light, moderate, or heavy.

(*d*) Number of men sent to the fire as they are dispatched, and time of
parture.

(*e*) Whether there are sufficient men to handle the fire, whether more men are
eded, etc., as determined from reports of initial attack men.

(*f*) Time and number of reinforcements dispatched.

(*g*) Report of control of a particular fire.

3. This graphic method will—

(*a*) Provide information on the path of the storm.

(*b*) Indicate the extent of precipitation, which will help the dispatcher to
termine where his danger areas are.

(*c*) Help the dispatcher mobilize forces at desired locations and in numbers
quired to handle the situation.

(*d*) Provide the dispatcher with a picture of the location of each fire and the
mber of fires involved.

(*e*) Show the fires to which forces have been dispatched and the number of
en involved, as well as follow-up forces required, when fires are controlled,
ose still giving trouble, etc.

(*f*) Prove of assistance in the development of a plan for follow-up detection,
ther aerial or lookout or both, after the storm.—H. S. PALMER, *Timber Manage-*
ent Assistant, Sitgreaves National Forest.

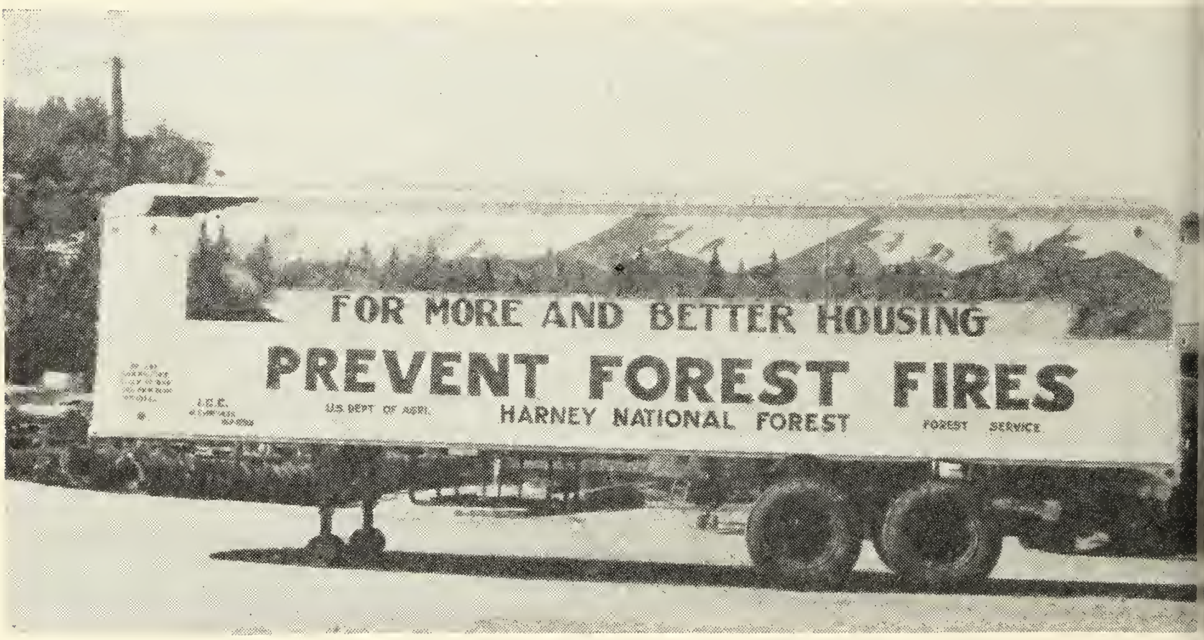
ROVING FIRE POSTERS

Alan A. McCready

Staff Assistant, Harney National Forest, U. S. Forest Service

In the Black Hills area commercial trailers are often used for advertising, the trucker furnishing the space and the advertiser the material and artistic skill. Many of these trucks cover a wide range of territory and are seen by a great many people. This seemed an effectiv way of putting over a fire-prevention message.

The Buckingham Transportation Co., who also have national fores timber contracts in South Dakota and Colorado, were first approache with this idea. They offered the use of a brand new 40-foot traile Its maiden run was to be to Minneapolis, after a trial appearance i the "Days of '76" parade in Deadwood; and runs to Denver and Ogde followed.



Harney fire prevention sign on the Buckingham trailer.

Several of the Harney people collaborated on the idea for the la out, and Forest Service painter Carl Wiehe, who has a flair for pan ramic paintings, carried it out. About 10 different colors and shad of synthetic enamel, adapted for outdoor weathering, were used. Tl punch line was painted in bright red.

A second trailer, operated by Roy Bristol between Custer, S. Dal and Denver, is now carrying a similar fire message, though with different public appeal approach.

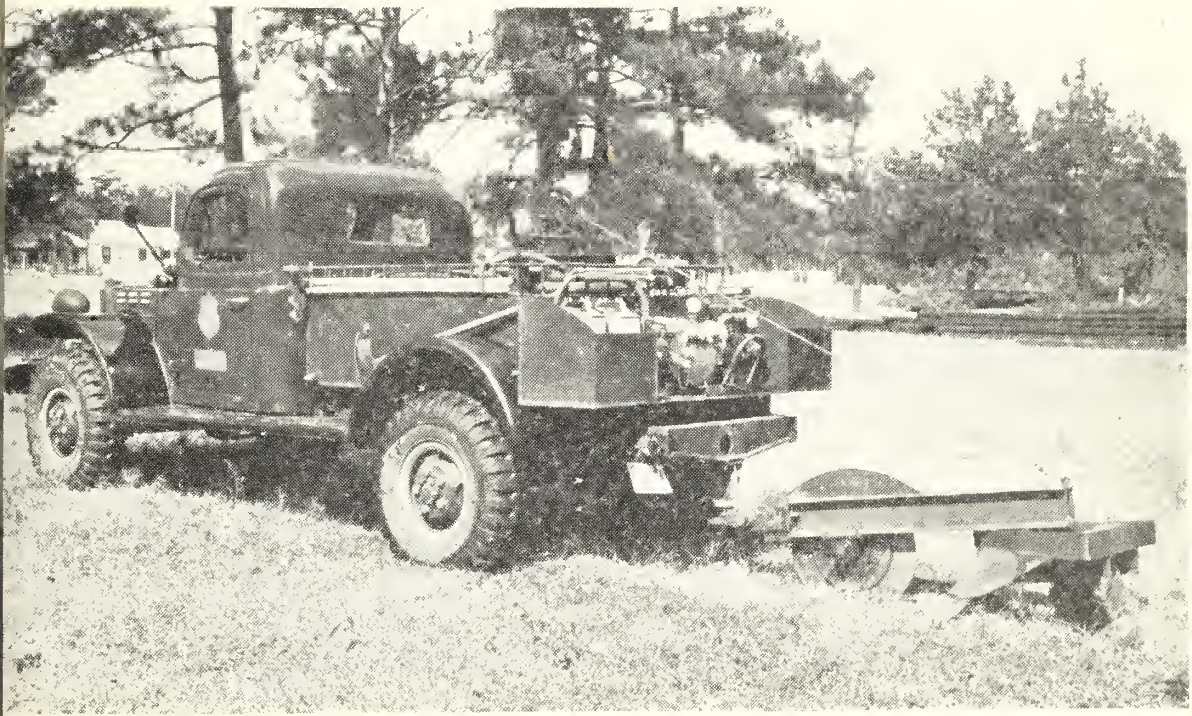
These large trailers are well suited to this type of advertising. Tl surface is expansive and usually unbroken, and the base paint is nece sarily high-quality weather-resistant enamel. We know this way plugging forest fire prevention gets across to the public by the numb of favorable comments we have heard about it.

FLORIDA'S MOST MODERN FIRE TRUCK

OWEN R. DOUGLASS

Fire Control Chief, Florida Forest Service

To combat woods fires under the special conditions offered by Florida errain, the Florida Forest Service has developed what we consider one of the best all around combinations, an all-purpose fire-line plow and ire-fighting vehicle.



Truck with middlebuster plow lowered by the hand-operated winch nearly to working position.

This is the 1-ton Dodge power wagon equipped with 9.00x16 mud and snow tires, and a front-mounted winch. It is the standard commercially manufactured truck to which has been added certain special equipment by the Florida Forest Service. Although rated at only 1-ton capacity, the truck has been loaded considerably beyond the 1-ton limit through the use of helper springs.

Limited experience in operating these trucks with heavy loads has not indicated that any particular trouble will develop. The trucks are purchased with cab and chassis only, then a 275-gallon specially constructed tank is mounted on the chassis. The tank weighs 800 pounds empty and 3,000 pounds filled. A compartment is constructed into the tank at the rear for mounting any auxiliary pump. The weight of the auxiliary pump and engine is about 200 pounds.

The plow, illustrated in the photograph, was designed and developed by the Florida Forest Service at Lake City during the summer month of 1947. It is a middlebuster plow capable of making a fire lin approximately 4 feet wide under almost any Florida conditions.

It is a simply constructed plow, using the rolling coulter and middle-buster principle for operating. The plow is attached to the truck by a specially constructed draw bar mounted between, and fastened to, the rear of the frame. It is easily detachable. It is hinged both vertically and horizontally in order to allow it to be raised and in order to allow it horizontal leeway for tracking behind the truck when in the ground A simple hand-operated cable winch is used for raising and lowering the plow. The weight of the plow is approximately 600 pounds. I is manufactured in Lake City and distributed from Jacksonville.

By using the low-range transfer case and four-wheel drive of th Dodge there is more than ample power for pulling the plow withou overloading the engine.

Use of the plow during the actual suppression work saves much tim in mopping up fires, and with the present scarcity and high cost o labor it is believed that the plow will more than pay for itself i one season.

This unit is located in St. Johns County, Fla., and indications ar that the operation will be most successful.

A Simple Binocular Holder.—Many ingenious towermen with time on thei hands think up a lot of good ideas but say nothing about it. On a trip throug New Hampshire with Bill Branch of the Chief's office, we visited a tower whic had a binocular mounted on the rear sight of the Osborne fire finder. Bi Emerson, lookout watchman at the Warner Hill Tower (near East Derry, N. H for many years operated by the New Hampshire State Forest and Recreatio Commission), gave birth to the idea which may be of use to others. Emerso made the device for his personal convenience, but it also appeared to be partic larly useful in making a systematic search of the terrain.

The device is simple and cost of material should not exceed 50 cents. A lig metal window sash pulley was cut off midway and attached to a ¾-inch woode block about 4 by 5 inches in size. A light metal spring clip for holding th binocular in place was fastened on top of the woolen block. The open portio of the sash pulley fits over the rear sight of the alidade. The binocular suppo is adjustable which facilitates a systematic search of terrain between tower an horizon.—Edward Ritter, *Region 7, U. S. Forest Service.*

Dawn Patrol.—As one means of meeting the hunter fire problem, the Stanisla National Forest in Region 5 has been using what is known locally as the "Daw Patrol." One such patrol, actually an evening patrol, is made the afternoon an evening prior to the opening of the deer season. The rest are made on week en and especially Monday mornings at dawn.

This prevention approach is simply a plan-wise method of assuring person contact of every hunter camp to check the proper care of campfires, issue smoki warnings, and detect and extinguish unattended campfires.

The forest is blocked out into small natural units and every able-bodied m in the organization is assigned a unit. The units are balanced in size dependi upon concentration of hunters and distance to cover. It usually requires fro 2 to 4 hours to cover a unit.

On one Monday morning dawn patrol, eight unextinguished campfires we located and put out. In 1946 with 20,000 hunters, two fires were caused unextinguished campfires. In 1947 one fire was caused by a campfire. In a three cases, the responsible parties had not been contacted by the patrol.—Neal Rahm, *Assistant Forest Supervisor, Stanislaus National Forest.*

FUNDAMENTALS OF FIRE BEHAVIOR

H. T. Gisborne

In Charge, Division of Forest Protection, Northern Rocky Mountain Forest and Range Experiment Station

[Used May 5, 1947, at 40-man Fire Boss School.]

Our job of fire control can be done, in fact has been done, in several ways: By brute strength and little attention to the conditions we are attempting to control; by observation of what is happening but with little or no understanding of why the fire is behaving as it does; or by practical application of knowledge of the basic laws of chemistry and physics that are actually determining the rate at which a fire is spreading. Let us look into the most significant factors that affect fire behavior.

FIRE IS A CHEMICAL PROCESS

Combustion is a chemical process. It is classified that way because combustion, with or without flame, is a molecular reaction in which molecules of oxygen in the air combine with molecules of cellulose and lignin (which make wood) and thereby change most of the solid into gases. These gases are molecules of different substances. They are no longer cellulose and lignin. Such changes of substance are chemical not physical processes. When these changes occur at such a rapid rate that heat and flame are produced the process is called combustion or fire.

When you look into the fundamentals of combustion and find that there are only three basic factors or three essentials to this chemical process it is obvious that we are overlooking a bet if we fail to consider each of these three things in our calculating.

Three Essentials of Combustion

Completely controlling the chemical reaction called fire are only three essentials. They are: (1) Fuel or something that will combine with oxygen rapidly enough to generate heat; (2) heat enough to raise that fuel to the ignition point; and (3) plenty of oxygen in contact with the fuel or with the gases evolved from the wood. Remove the fuel as we do when we dig a fire trench, keep it from being heated to the ignition point, as we do when we widen the trench or when we use water, or shut off the supply of oxygen as we do when we throw dirt, use water, or bury a burning log, and you can stop the spread of any fire. *Every one of our methods of fighting fire is based on one or more of those three simple essentials.* THERE ARE NO OTHER WAYS.

1. Fuel.—Chemically all of the fuels that carry our fires are practically alike. From grass and brush to tree needles, tree trunks, and rotton wood on the ground they are all of the type that the chemist designates as $(C_6H_{10}O_5)_y$. This means that there are 6 atoms of carbon, 10 atoms of hydrogen, and 5 of oxygen in each molecule of cellulose. Starch, which is found in the roots, seeds, and leaves of all plants is very similar, differing only in the subscript. The chemists designate the various starches as $(C_6H_{10}O_5)_x$.

This point is important to remember because it helps to reduce some errors of judgment based on the belief that the chemical nature of our fuels differs very materially. When $C_6H_{10}O_5$ burns every molecule of that substance combines with six molecules of oxygen. The resultant products are gases, 6 molecules of carbon dioxide, and 5 molecules of water vapor. Fire makes water out of the hydrogen and oxygen atoms that are in every molecule of wood. The chemist writes it this way: $C_6H_{10}O_5 + 6O_2 \rightarrow 6CO_2 + 5H_2O$. Unfortunately that water is not of any help to us because it exists as a gas, a superheated gas, which rises straight up and away from our fuels. The water that really counts is the moisture content of the grass, trees, or brush before they burn.

Because of this similarity of chemical composition of our fuels it is obvious that we should not calculate probabilities on the belief that different kinds of wood or brush or grass burn differently. The leaves of grass, trees, and brush, and the bark and wood of trees are all largely cellulose. The big variable which produces really significant differences in fire behavior is not the chemicals, it is the moisture content.

There are, however, two other ingredients in wood in addition to cellulose that are of some, perhaps academic, significance. One of these is lignin, a substance for which the chemists do not know the formula. The significance of lignin lies in the fact that it has a slightly higher heat content than cellulose and that it leaches and decays more slowly. Hence old wood is likely to have lost more cellulose than lignin and therefore will have a slightly higher heat conten per pound of material remaining than fresh cut or freshly killed wood Differences in the pitch content are also known to affect the heat of a fire.

There are also some other minor differences in the chemical natur of plant and tree leaves but a series of tests of the fat and oil conten of the leaves of six different genera of weeds and brush which wer made for three consecutive summers failed to reveal anything significant. Instead this chemical study made at our Priest River laborator confirmed the finding that moisture content is THE big variable.

2. Ignition.—When there is plenty of fuel, the next essential o combustion is that it must be heated to the ignition point. For dr cellulose a temperature of only 400° to 600° F. is required. Th average usually used is 540° F. The point that is of practical importance is that if your fuels are even moderately dry they do not hav to be heated very hot to reach this ignition temperature. In othe words the kindling temperature of grass, wood, cotton batten, or cellulose in any natural form is easily produced. It is not an abnormall high temperature. You will build more held line and have to charg up less line lost if you remember that simple fact and then do something about it.

The key to ignition is the ease with which a fuel can be heated to 540° F. That ease naturally depends upon one obvious difference in fuels, . e., their size. The fine fuel naturally heats clear through and reaches 540° far quicker than a heavy fuel like a log. Size of fuel is therefore he significant feature to watch, other things such as moisture content being equal. Actually, size and moisture content influence the process of combustion in much the same way. Make a stick wetter and you reduce its ease of ignition. Similarly, the bigger the stick the harder it is to ignite it. The wet stick and the big stick both require more time or more heat to raise their surface temperature to the ignition point. And that is another good basic fact to keep in mind both n sizing up probable fire behavior and in deciding on tactics to use along the line. Let your fire burn through the heavier fuels where it will burn more slowly. Fight it at those places where it would go into finer fuels and spread faster. Also, fire line construction is easier in he fine fuels. You gain in two ways by using this basic knowledge.

Size of fuel is also worth noting from another angle. Take 10 pounds of dry grass or dead pine needles, 10 pounds of dry branchwood, and 10 pounds of log in one chunk and ignite each of them. What happens? The needles will liberate their B. t. u.'s (British hermal units) in a few seconds, the branches will release theirs in a few minutes, while the 10-pound log may take half an hour to release its heat. Ease of ignition is, therefore, not the only difference in fire behavior to expect in accordance with different sizes of fuel. The rate of release of the energy is also tremendously different.

This feature, combustion rate, is what a football player would call he triple threat of fire. And this rate of release of energy is the one feature we fail most often to recognize. The three threats involved are: (1) The more sudden the release of all this heat the farther it will radiate a temperature of more than 540°. And that means something to your tactics. It means that if the fuels are even moderately dry, a wider fire line is needed wherever you find an appreciable volume of fine fuels. This applies to both stopping a fire and in backfiring. (2) The faster the release of those B. t. u.'s the greater the volume of gas suddenly created, hence the faster it will rise overhead. That also means something to tactics employed, because the swifter the rise of hot air the greater the chance of sucking up blazing embers and carrying them up and over the line, if the smoke is leaning across the line. That means spot fires. (3) The faster this release of energy and the faster the uprush created by it the greater the local wind velocity created by the fire. Moderate to large areas of fuel releasing their energy suddenly are creating conditions that breed not only higher wind velocities but twisters or even big whirlwinds. I once saw one of the really big ones whirl like a tremendous barrel and move across 2 square miles while I was running 200 yards along the top of Desert Mountain, on the Flathead Forest.

3. Oxygen.—This last essential of combustion is one that we can't do very much about. Combustion engineers who design and operate boilers do a lot by controlling this one of the three essentials. But under our conditions there is almost always plenty of oxygen to facilitate combustion of our fuels. Under free burning conditions such as occur on a forest fire about 10 pounds or 133 cubic feet of air is needed for the complete combustion of only 1 pound of dry fuel.

The one time when we do something to reduce the oxygen supply is in throwing dirt. While that dirt does lower the temperature of the fuel it lands on, the principal function of dirt is to shut off or at least reduce the supply of oxygen. Moist dirt is superior to dry dirt primarily because it lowers the temperature more. But when either moist or dry soil covers the surface of the fuel the major benefit is by cutting down the oxygen supply. Water also does the same thing if enough is applied to form a film over the surface of the fuel. But here too the major benefit is in lowering the fuel temperature below the ignition point.

Combustion a Molecular Chain Reaction

The public has heard and read a lot recently about atomic fission so controlled that it becomes a chain reaction and thereby makes possible atomic bombs. More understanding of the fire job and better financial support by the public may follow when we show that the job of fire control is definitely one of stopping a chain reaction which differs from the bombs primarily in that ours is a molecular instead of an atomic chain reaction.

A chain reaction may be compared to a chain letter; you receive one but you send out two or maybe three or four. Each of the recipients of one of these letters similarly sends out two or three or four. The thing spreads like wildfire. The first problem in producing an atomic bomb was along this line. That problem was to obtain certain chemicals which when assembled in a sufficient quantity and arrangement known as the "critical mass," would perpetuate the process of splitting atoms of uranium into atoms of two other elements, barium and krypton. It was known as far back as 1939 that in this splitting tremendous energy was released and that the process then split other uranium atoms which in turn released more energy and split more atoms, the process continuing and accelerating as long as there was a supply of a suitable fuel in a proper arrangement and condition. The job of the atomic physicists was, therefore, to produce this chain reaction yet control it. Our job is simplier. It is merely to control the molecular chain reaction that is fire.

As you can see, fire is a similar process in that if you heat one molecule of a fuel to the ignition point its process of changing from $C_6H_{10}O_5$ into CO_2 and H_2O may release enough energy to ignite several other adjacent molecules of $C_6H_{10}O_5$. If the fuel is in a critical condition (dry enough), as compared to a critical mass (large enough), that process then becomes a chain reaction and not only spreads like wildfire but it really is wildfire in our case. Whereas the nuclear physicists have to make their fuels, and arrange them carefully in an atomic pile, our fuels are arranged for us and then, periodically, are put into proper condition (dryness) such that the chain reaction starts whenever and wherever the spark is applied.

If this sounds farfetched or academic let me call your attention to one more fact, which I know you will not dispute. It is this: That when our fuels are in their most critical condition, i. e., their driest, we have some molecular chain reactions which are so violent that we *cannot* stop them, just as there is no stopping an atomic bomb once its chain reaction is started. Furthermore, we have occasions when combustion in the form of a forest fire approaches a rate and even magnitude rivaling an atomic bomb. Those of you who were on any of our big fires in 1929, 1931, and 1934 probably saw some of these explosions. Many of them covered several square miles in only a minute or two.

If you will keep this chain reaction idea in mind, and if you will size up your fire, either as a whole or on your sector, in the light of the three basic essentials of combustion you may be able to calculate the probability of one of these explosions. If you can do that you may be able to save your own life and the lives of your men, as well as improve your fire control tactics.

There is one basic criterion to watch, however, in trying to anticipate a molecular chain reaction at an explosive rate. This is moisture content of the fuel, for it is moisture content not mass, nor volume, nor size, nor arrangement of fuel which *first* determines whether or not a forest fire can truly explode. And you should remember that this moisture content not only can be but is being measured. You can get these measurements every day if you want them.

MOISTURE CONTENT THE CRITICAL VARIABLE

We have not had any true forest fire explosions in Region 1 since 1936. I believe there were a couple of minor ones that year on the Little Rockies Fire on the Lewis and Clark Forest. But we had several really big ones in 1934, 1931, 1929, one or two in 1926. You have all read about those in 1919 and 1910. The main reason why we have not had any explosions in recent years is this matter of moisture content. Our fuels simply have not dried out to the critical condition that developed in those earlier critical years. Hence, it is evident that the critical variable in fire behavior is moisture content of the fuels. Consequently I want to call your attention to some of the possibilities available to you for improving your calculation of probabilities by watching fuel moisture above all other elements.

Basis of Fuel Moisture Measurements

You all know about the fuel moisture indicator sticks used at some 175 fire danger stations in Region 1. There are some things those sticks will tell you far better, far more accurately than you can estimate. To make best use of those stick measurements you need to know: Why we use half-inch sticks, how they are made, and how accurate they are.

For four consecutive summers, 1922, 1923, 1924, and 1925, I collected at periodic intervals samples of the the five major dead fuels that burn in a forest fire. I took these samples to the laboratory and determined their moisture contents. I found out which fluctuated the most, and which the least. On this basis I selected the top layer of duff, half-inch sticks, and 2-inch-diameter branchwood as the best representations. We therefore used duff hygrometers, half-inch sticks, and 2-inch sticks at several fire danger stations for the next 5 years to measure fuel moisture. Then at the suggestion of the rangers in a regional meeting and despite my protest, we discontinued used of the 2-inch ones. Finally in 1942, with the Model 6 Danger Meter, we dropped duff moisture and began to rely solely on the half-inch sticks.

From a technical viewpoint these half-inch sticks alone fail to represent our fuels in two ways: (1) They do not show the true benefits of light rains as well as duff moisture measurements did; (2) after heavy rains they dry out faster than either duff or 2-inch-diameter sticks. The error is therefore always toward showing more danger than would be revealed if all of the significant *forest* fuels were measured. The half-inch sticks are not too fast, of course, for cheatgrass but this fuel type does not cover a large percentage of our area Furthermore, after it has cured, cheatgrass responds so closely to changes of relative humidity that humidity measurements can very well be used as an index of moisture content of that one fuel type Finally, cheatgrass changes moisture and flammability so rapidly that you might as well always be ready for the worst.

The half-inch sticks which we now use are made from new lumber each year. Any one of several species of wood could be used, because here again we are dealing primarily with cellulose. We use ponderosa pine because it is readily obtainable in clear stock at a reasonable price We use only sapwood because it is the moisture content of sapwood of twigs, branches, logs, and snags in which we are most interested We can ignore the moisture content of the heartwood of a log because if the outer sapwood is extremely dry the inner heartwood has got to be dry too. We also ignore the effect that bark has on natural wood because if we used natural sticks with bark on them some of that bark would soon chip off and then we would no longer know the true oven-dry weight of our sticks.

To be sure that moisture measurements made at different stations do not differ because of differences between the sticks or because of errors by the danger station operator, we go to a lot of work and incur considerable expense. These sticks now cost from $1 to $1.75 per set to manufacture. In making them they are oven-dried and then cut off at the ends until they weigh exactly 100.0 grams *oven dry*. This is done so that all that is needed to determine their moisture content in percent is to weigh them and subtract 100.0 from the total weight.

As you can see, this difference in weight is not only the weight of the water in the wood, picked up from the air and from rain, but it is also the moisture content expressed as a percentage of the oven-dry weight. Consequently, when you call for a fuel moisture content measurement from any of our stations you can bank on its accuracy probably 95 times out of 100. The other 5 times the scales will be out of balance, which is an operator error, or the operator will have read the scales wrong. Eliminating that error is a job for training and supervision.

Application of Stick Moisture

By the present practice we measure stick moistures at only two to four occupied stations per ranger district. That is not enough under some conditions of spotted weather, wet here and dry there, but under widespread and long continued drouth it is fully adequate. The sticks are exposed on a flat, in the open, but under a shading layer of screen cloth. The reason for this, preparing to meet "average-bad" conditions, is used in all fire control planning in Region 1. The sticks are therefore always exposed alike at all stations so that the results are truly comparable.

The intention in such an exposure is to sample average-bad but not the very worst conditions. By sampling average-bad conditions we are using the sound engineering principle of preparing for the worst probable but not the worst possible. Engineers did not build the Golden Gate Bridge at San Francisco to withstand the worst possible earthquake. They built it to withstand the worst probable. Few ditches, storm sewers, or bridges are built to withstand the worst possible flood. To meet worst possible conditions usually costs more than the resource is worth. It is better economics therefore to accept the risk of the worst possible flood, earthquake, or fire weather conditions, and plan to meet only the average-bad or worst probable. We can get adequate fire control at a justifiable cost by using this principle. We do use it, not only in fire danger measurement, but also in all phases of fire control planning in Region 1.

The double layer of 12-mesh screen cloth under which we expose our sticks provides an amount of shade and a fuel-moisture equivalent to what you would get if you operated two danger stations, one in full sun and one under the half shade left after a moderately heavy logging operation. The stick moistures obtained by this method can therefore be accepted as representing average-bad conditions. Open south slopes will have drier half-inch sticks. Densely timbered north slopes will have materially higher fuel moistures. But when the sticks at our stations have high moisture contents, adjacent areas, both open and timbered, also can be expected to be moist to wet. When our sticks are each day showing lower and lower moistures you can depend on it that both the open areas and the timbered slopes will also be getting drier and drier.

Our present sticks and exposures therefore give you one definite and dependable index to watch. They give you something that you can use in calculating, instead of guessing.

The most significant single feature of stick moistures to watch for is just this: Are they below 5 percent and how long have they been there? Your danger of blow-ups and explosions can be really calculated by getting merely that information. If the sticks at both the nearest ranger station and some nearby lookout have been down below 5 percent for several days you can bank on it that every fuel type in that area is in a truly critical condition. Fortunately this does not happen very often, but it has happened and it will happen again. When it does you will be making the mistake of your life if you fail to know it. You can always find out by consulting the local ranger station fire danger charts or Form 120 R–1. If you are already out on a fire a phone call will bring you the desired information.

If the sticks are reported as at less than 5 percent you should then ask for two more things: a check of the computations to be sure no errors were made, and a remeasurement of the sticks right then. The dispatcher or his assistant can do both of these in 10 or 15 minutes. If these checks verify the original reports you can then *calculate* that every fuel type in the area, on both north and south slopes, and at all altitudes, is in its most explosive condition. You can bank on it that fire will spread in all of these types at the fastest rate, that there will be little difference in rate of spread between fuel types, and that the danger of both spotting and of big whirls will be at a maximum. You can expect a chain reaction at its worst.

Those of you who have never seen fires like the Lost Johnny an Half Moon on the Flathead in 1929, the Freeman Lake on the Kaniks and the McPherson on the Coeur d'Alene in 1931, and the Pete Kin on the Selway in 1934, simply cannot fully appreciate the significanc and the danger under these conditions. It may be enough to poin out that the Freeman Lake Fire, starting at 10:30 a. m. on Augus 3, 1931, exploded almost from the start to cover 20,000 acres in th next 12½ hours. This is at the rate of 1,600 acres per hour, from standing start! Both duff and 2-inch-diameter sticks were down to percent moisture content that afternoon. Wind was 13 miles per hou at 10 a. m., and 18 miles per hour at 7 to 8 p. m. Relative humidit was 10 percent or lower from 2 till after 7 p. m. THAT is explosiv fire weather.

Differences in rate of spread between fuel types practically disappear under these explosive conditions. The basic laws of chemistr take charge when nature produces such conditions and the molecula chain reaction is actually unstoppable until the wind goes down, th humidity goes up, and the fuels absorb a little moisture. If you hav to fight such fires, and you should be mentally ready for it, you wil probably do it like Kelley and Ryan fought the Freeman Lake explosion. You will not build much fire line that day, but you will calculate where that fire front will be at midnight and you will the have fire camps and men well distributed around it and ready to begi work at the first crack of dawn. Kelley and Ryan had more tha 600 men strung around the Freeman Lake Fire front the next mornin after that fire started, and those men never let that fire make anothe major run. That is a record to shoot for; it has seldom if ever bee equalled in this region.

The real difficulties and the most frequent need of skill and understanding by fire bosses come, however, in judging gradations betwee this explosive condition and that easiest of all conditions when fir will spread, but only so slowly that control is largely a problem o how to do it at the least cost. In between this explosive conditio and the easiest condition other factors than stick moisture become more and more important and all the factors become muc more involved. It should be evident, nevertheless, that fuel moisture is THE major variable and that if you are to calculate accurately, your first and best bet is to get the stick moistures and othe measurements from the nearest danger stations *before* you even star to order men. After you get to the fire you can then see to it tha you are informed each day, preferably twice a day, as to how fue moisture and other factors are changing. There are then three othe major variables to watch. These are fuel type, the thermal belt, an wind.

FUEL TYPES

Some men have a misconception about fuel types because they d not understand that our four rates of spread—Extreme, High, Medium, and Low—represent differences only on a class 65 to class 7 day. Obviously, rate of spread will not differ at all in different type when the woods are soaking wet. Also, rate of spread is very nearl the same in all types after several August days with the temperatur at 100°, humidity at 10 or 15 percent, and the afternoon wind at 15 to 20 miles per hour. Hence, we have used the principle of preparing for the average-bad in our fuel type classification, and the rates given on our fuel type maps are those to be expected on an average-bad day. This is about class 70 on our burning index meter. You cannot use those fuel type maps correctly, or dependably, on any other basis.

Our fuel type classes are therefore based on differences in rate of spread, not at the explosive point where we can do nothing about it, but at combinations of moisture contents, wind velocity, and vegetative conditions just short of the explosive point. These begin early in August whenever fuel moisture drops to 5 or 6 percent, the humidity falls to less than 15 or 20 percent, and the wind rises above its normal afternoon average of 6 or 8 miles per hour. After several days of such weather, especially if the burning index rises to 75, as it will with fuels under 5 percent, humidity under 10 percent, and winds of more than 10 miles per hour, differences in rate of spread become less and less as all fuel tyes approach the explosive condition.

A burning index rating is therefore essential to calculation of the probabilities in any fuel type. If it shows class 65 to 75 you can count on the differences shown by the fuel type map, insofar as that map is well made. The weaknesses in these maps are well recognized and steps are being taken to correct them.

In applying the burning index to a correct fuel type map some guides have been worked out, but this is unfortunately a field in which our fire reseach has been woefully weak. Our best contribution is in U. S. D. A. Circular 591, Influences of Altitude and Aspect on Daily Variations in Factors of Fire Danger, by Lloyd Hayes, published in 1941. The outstanding new fact resulting from this research was the discovery and general location of what Hayes called the thermal belt.

THERMAL BELT

The major significance of this thermal belt is that inside a certain altitudinal zone burning conditions change less from daytime to nighttime than they do in either the valley bottoms or on the mountain tops. At Priest River this zone begins about 600 feet above the valley bottom and continues upward for about 1,000 feet. Below and above this zone fuels pick up more moisture at night than they do within it. Within the zone the fuels lose a little every afternoon and pick up a few percent between 6 p. m. and 3 a. m., but the change is very slight. Up on the mountain top, however, the same fuels will pick up 4 percent more at night and lose 4 percent more in the daytime. Down in the valley bottom they will pick up and lose 8 to 12 percent more than within the thermal belt. This is true on both north and south aspects. The only places where it may not hold true are in steep-sided, deep, east and west canyons like that of the Salmon River. In that canyon and perhaps in a few other spots like it, the depth of the canyon and its orientation in relation to prevailing winds combine to interfere with normal air drainage. There the thermal belt effect becomes less pronounced or even disappears. Sometimes going fires will also disrupt this belt, if the fires are large enough, but in most places and under most conditions you should calculate your probabilities on the basis of the known difference of burning conditions within this thermal belt.

The next time you have a fire starting in late afternoon or early evening about 1,000 feet up from the main valley bottom, I suggest that you note for yourselves whether or not that particular fire does not run faster and for more hours during the night than a similar fire in the valley bottom. Also note whether or not that fire picks up and starts to run earlier in the morning. I think you will find both of these conditions in almost all thermal belt fires. They are essential elements in the equation required to calculate the probabilities.

These facts also should be highly significant to all fire dispatchers. Other things being equal, more men should be sent, and they should be speeded on their way faster to every fire in the thermal belt. Furthermore, on a going fire, if night work can be done on any sector, it should be planned first on those portions of the front from 500 feet to 2,000 feet above the valley bottom, because this is the zone of the thermal belt. Within this zone you can expect the least benefit from increased fuel moisture at night.

WIND

Although fuel moisture is the critical variable that puts all fuel types in an explosive condition, or reduces them to an easy job of fire control, wind velocity is often the straw that breaks the camel's back. In fact at fuel moistures of 6 or 7 percent up to 20 or 25 percent, wind is often the variable which finally determines what a fire will do. Some basic research by Fons at the California station has shown that with fuel moisture at 8 percent variations of wind velocity are more significant in changing the rate of spread than are variations in fuel temperature, fuel size, compactness, or density.

Whether or not some fire seasons are, as a whole, windier than others I do not know. But we do know that wind is a result of certain meteorological conditions which change periodically at from 3- to 5- or 6-day intervals. If you will watch the wind record portion of any fire danger station chart, particularly for a lookout station, you will see a gradual increase of wind for several days, then a decrease, then another increase. Obviously, by watching this up and down trend you can definitely improve your calculation of the probabilities, even though you cannot forecast precisely.

There are a few general rules of wind behavior which can be used locally in Region 1. First, is a discovery, made by Hayes and described in Circular 591, that the places of greatest wind danger at night are, strange as it may seem, the north aspects at high altitudes. To put it another way: While you can usually count on the wind dying down during the night in the valley bottom, you should not count on this if your fire is up on the high divides between major drainages. Instead, at the higher elevations you should expect the highest winds at night, not in the daytime, and more wind on the north aspects than on the south.

Another general law of wind behavior during the ordinary fair weather of June, July, and August, that is quite well known, is that during the day the wind usually blows up the canyon or creek, while uring the night it blows down canyon. This reversal of direction n the evening usually takes place just a few minutes after sundown. Vhen both the daytime and the night winds are very light—less than miles per hour—this reversal may not be of much significance. Iowever, in topography and on areas which are materially heated by ie sun's rays, the afternoon wind created by rising hot air may amount o 8 or 10 miles per hour. When this is the case reversals at sundown nay produce a significant down-canyon wind. This condition is most ronounced on south aspects and in watersheds draining toward the outh into a big canyon running east and west, like that of the Salmon River. But even under these conditions a large fire may create such an pdraft as to upset the normal reversal of wind. Hence, while this enerality is worth considering in your calculations there are other facors which also must be recognized before you make your final estimate f rate of spread.

From what has been said it should be clearly evident that "calculatng the probabilities" means doing much, very much *more* than just ght a fire with brute strength and numbers of men. It means careul consideration of every available source of information concerning ach of the basic factors of fire behavior. But even when that has een done you will still have to use judgment, and perhaps even do some ure guessing. Nevertheless, your batting average is absolutely cerain to increase IF you first do the best you can to calculate on the basis f facts and known principles.

EXPERIENCED JUDGMENT

Perhaps I should not close on this point, because if by doing that cause you to discount *any* of the things previously called to your attenion then I weaken my point. However, in fire control there are still lot of basic factors not yet understood or not yet measured. And ven when they are measured the basic facts must still be put together, veighed one against another, and a balanced decision then reached. Vorse yet, sometimes that decision must then be modified or even eriously compromised on the basis of what you *can* do about it.

Experienced judgment is therefore the final determinant of what ou actually do, both in planning to control a fire and out on the fire ine where you try to put your plan into effect. But if you will stop o examine just what is meant by experienced judgment you will come ack to the items I have listed above. For what is experienced judgnent except opinion based on knowledge acquired by experience? If ou have fought forest fires in every different fuel type, under all ossible different kinds of weather, and if you have remembered exactly vhat happened in each of these combinations of conditions, your expeienced judgment is probably very good. But if you have *not* fought ll sizes of fires in all kinds of fuel types under all kinds of weather hen your experience does not include knowledge of all the conditions. In that case some of the facts and principles described above should e helpful to you.

SUMMARY

There are only three things you can do to stop a fire—rob it of its fuel, keep it from being heated to the ignition point, or shut off the oxygen supply.

When it comes to fire behavior there are likewise only a few basic variables. The big one is fuel moisture and when our fuel moisture indicator sticks are below 5 percent you can expect your fires to blow up and explode. As that moisture content rises above 5 percent your fires become less and less explosive and you know that they are then more and more influenced by another major variable, wind.

Both fuel moisture and wind are measured every day of the fire season at numerous stations. Those measurements will show you clearly and accurately what the present moistures and velocities are, and how they are changing, whether getting better or worse. These are facts. They are available to you. They were not available to the rangers and supervisors who fought the fires of 1910 and 1919, nor to many men in 1928 and 1929. You therefore have this accurate knowledge that those men did not have.

Furthermore, you have some knowledge of how both fuel moisture and wind velocity differ according to altitude and aspect. The outstanding general differences are known. Very few if any of the most experienced old-time fire fighters knew these things.

And finally you have not only excellent topographic maps to help you visualize your fire area, but you have the major differences in fuel types shown clearly so that you can calculate what you should expect your fire to do on this particular slope in the next few hours.

It is true that you still have to estimate how much different the fuel moisture will be at your fire from what it is at the fire danger station. You also may still have to guess what the exact wind direction and velocity will be on your fire even after you find out what they are at the nearest ranger and lookout station. And it is true that there may be an acre of High-High fuel right near your fire even though the map shows Medium-Medium or even Low-Low. But if you have been on your district very many years and have gotten around, or if you have someone else there who really knows his fuels, you may be able to pick up that important fact.

CONCLUSION

Even though there are some holes in our information, we have much more than our predecessors. Those men had to think of EVERYTHING. They even had to go to town to buy their axes and shovels and grub. Then they had to remember out of their own personal experiences what the topography and timber and brush types were like, up there at the fire. Finally, they could only feel the wind and kick the duff to see how dry the fuels were, right where they stood. Finally they could look at the sky and guess at what the weather might be tomorrow. May be some of them prayed.

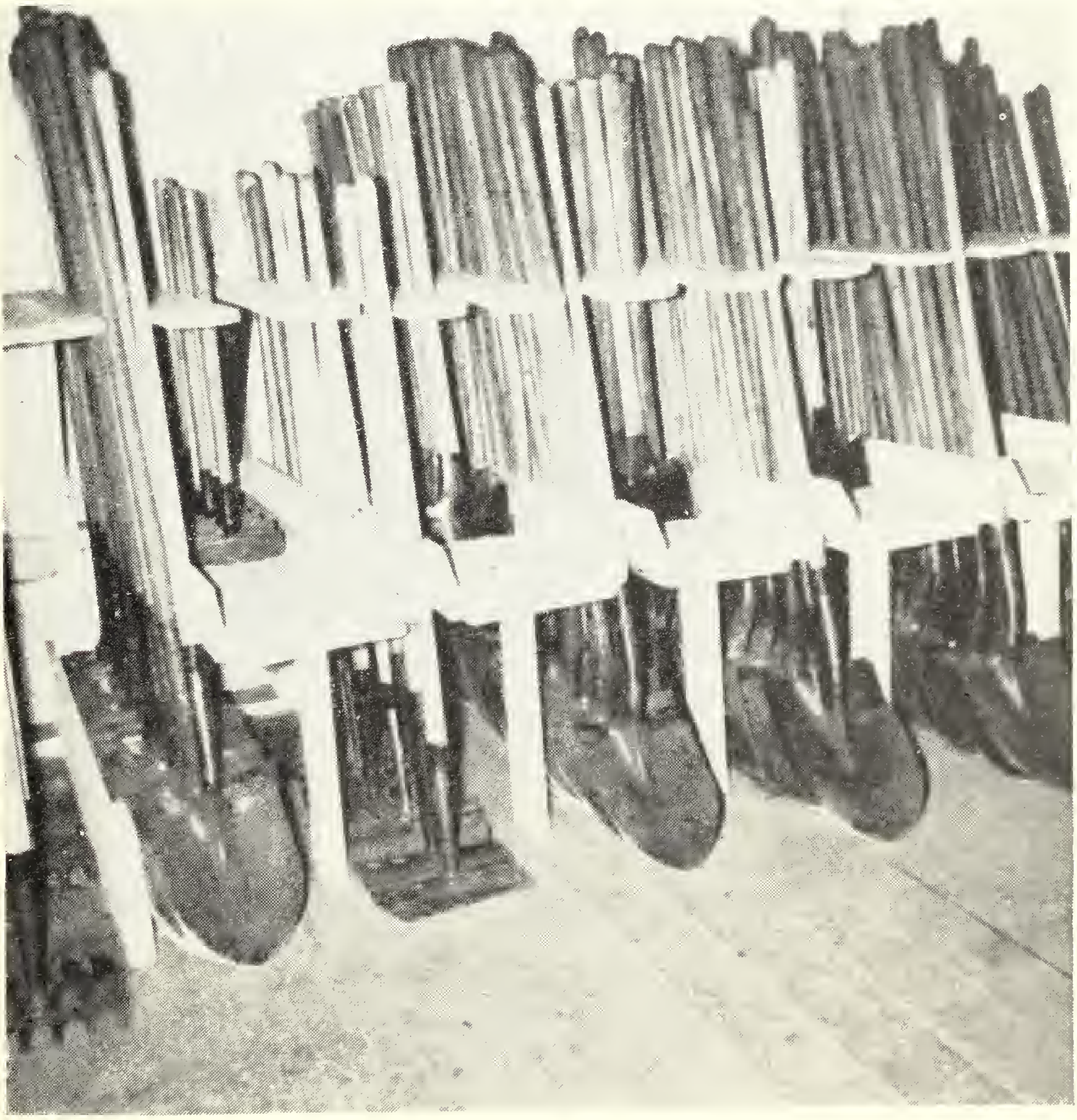
But times have changed. Where those old timers had to guess at most everything, today, we have measurements and maps and many other facilities. While we might like to have more, I doubt that anyone ever will be able to sit down to a machine, punch a key for every factor of the situation, and have the machine tell him what to do. Fire control still requires headwork based on knowledge. If we will make a purposeful attempt to use all of the knowledge and all of the facilities that are available to us today we can do one thing the old-timers could not do: We can come mighty close to getting adequate fire control, and at an operating cost far below what it used to be.

SAFE STORAGE OF FIRE TOOLS

R. W. Bower

Fire Control Officer, Modoc National Forest

The Modoc National Forest has two problems in connection with warehouse storage of fire tools. Warehouse space was limited and the method of storage needed to be safe. The ordinary overhead type of rack for shovels and McLeods was dangerous because of possibility of tools falling out of racks. The type of rack for axes that allows the ax to hang by the head is also dangerous because of chance of a person striking an exposed blade.



The tool rack shown in the photo solved both these problems. It is a very compact arrangement with maximum use of available space. It is a very safe arrangement because there is no overhead storage and it is always necessary to reach for the handle of each tool instead of the head or blade. There have been no accidents from handling loose tools in the warehouse since this system was installed.

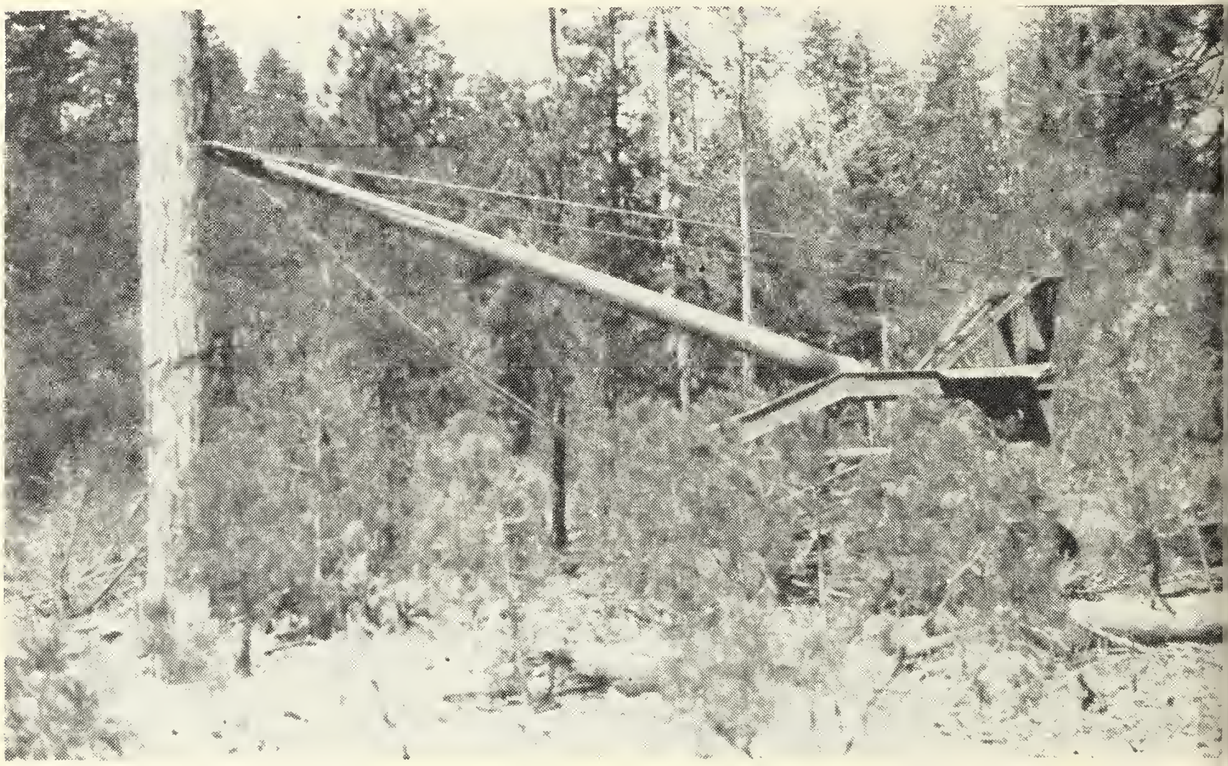
AN EFFICIENT SNAG PUSHER

R. W. Bower

Fire Control Officer, Modoc National Forest

One of the greatest fire hazards in the Northeastern California pine timber type is the presence of numerous snags due to past depredations of the pine beetle.

An analysis of all the class C, D, and E fires on the Modoc National Forest for a 5-year period showed that of all the fires starting in timber type, 70 percent were lost by the initial attack suppression crew because of snags throwing more spot fires than the crew could handle. The standing snags are far more dangerous than slash on the ground.

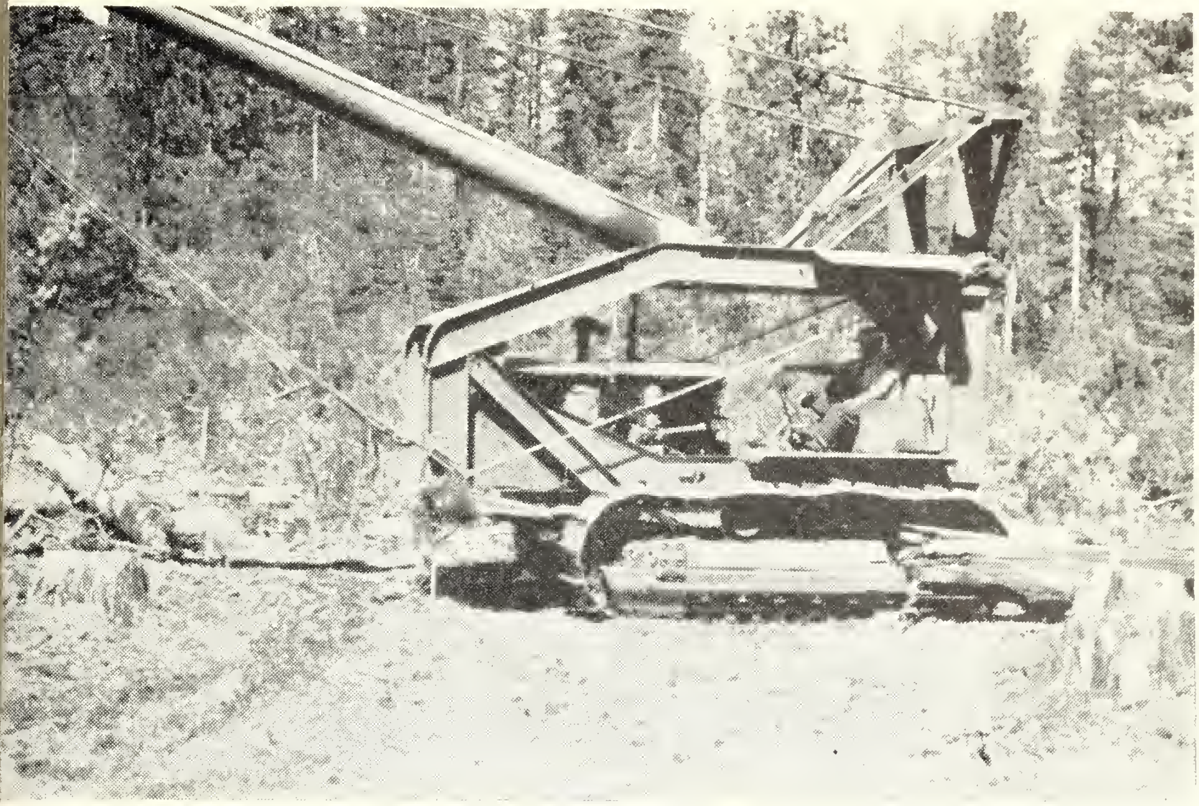


Snag pusher with boom against snag.

For this reason, any fire hazard reduction program must place snag disposal high in priority.

The Finney Logging Co., operating on lands of the Red River Lumber Co., within the Modoc National Forest boundary, has adopted the 100 percent snag falling alternative under the slash disposal requirements of the California State Forest Practice Act. Mr. Ted Finney, manager, has built a snag pusher in order to do the snag-disposal job economically and rapidly.

The main feature of this snag pusher is the 30-foot steel boom connected to a heavy channel iron frame and mounted on a D8 Caterpillar tractor as shown in the photo. Mr. Finney made the frame exceptionally heavy in order to afford maximum safety to the operator. It will stand the full weight of a falling snag if one should break back over the boom.



Arrangement of boom and frame on tractor.

This rig will push well over 300 snags per shift in heavy stands and will average about 200 snags per shift in average stand conditions of about $2\frac{1}{2}$ snags per acre.

The crew consists of an operator and swamper. The swamper tallies the number of snags pushed daily as well as scouts out best route for travel of rig from snag to snag.

Fire Fighting De Luxe.—Region 3 hates to see Region 1 dropping all that water from B–29's so we felt we should go them one better.

A letter has just been received from the Range Developing Co., Phoenix, Ariz., which says among other things:

"It might be interesting to you to know that on Friday afternoon, September 5, the writer discovered a small fire burning in the Prescott National Forest just east of Walker. While bringing about rainfall over the municipal drainage area of the city of Prescott, a thunderhead formed directly above this burning area. I flew into the thunderhead at about 5:15 p. m., dropping approximately 80 pounds of dry ice pellets which brought about an immediate heavy downpour. On circling the area about 6:30 p. m., there was no evidence of fire left. We have no reason to doubt this fire was definitely put out through our efforts alone."

On the same day Assistant Ranger Bill Anderson reports:

"Another man and I went to a small fire east of Walker. We had just got the snags felled when we observed a large cloud which we hoped might bring rain and heard a plane overhead. And in a few minutes, boy! did it ever rain—and hail. We got awful wet but it sure did put that fire out quick and saved mop-up."

The Region's position is obvious. We are certainly going to be much interested in every cumulus cloud—particularly next May and June—and are now considering the addition of raincoats to all our fire caches. No fooling!

Seriously, the Range Development Co. has offered free demonstrations and the region will take full advantage of the offer.—Don Beck, *Region 3, U. S. Forest Service.*

MAKING CONTACTS AND ESTABLISHING GOOD WILL

C. H. Coulter

State Forester, Florida Forest Service

In Florida 99 percent of our fires are man-caused, about 72 percent being deliberately set. This adds up to a tremendous human relations problem—the job of selling fire protection to an indifferent and often antagonistic public.

With this in mind, "Making Contacts and Establishing Good Will" was prepared. It was read, discussed, and taught at our fire control training schools. It is for towermen, assistant rangers, rangers, and others to use in properly approaching the public—the first step in getting their cooperation.

ATTITUDE OF PERSONNEL

In order to successfully sell the program of the Florida Forest Service to individuals and the public in general, it first becomes necessary for the individual employee to believe whole-heartedly in the purposes of the organization and the people in it. In other words, he must first sell himself on the idea that his organization is a good one, and that he has something to offer the public.

From time immemorial it has been proved that nothing is so contagious and stimulating to morale as individual and collective pride. If you thoroughly believe in, and are enthusiastic about your organization, you will soon transfer this enthusiasm to those you come in contact with.

By the same token, nothing will spread so quickly and cause as much discontent and corruption in an organization as a dissatisfied employee—for example, the individual who hangs on merely for the purpose of drawing his pay check, and who is constantly knocking and grumbling about the organization and those in it.

All of us will profit by recalling Elbert Hubbard's adage on loyalty: "If you work for a man, in heaven's name, work for him! . . .—speak well of him, . . . and stand by the institution he represents . . . an ounce of loyalty is worth a pound of cleverness.

"If you must vilify, condemn and eternally disparage, why, resign your position, and when you are outside, damn to your heart's content. But, I pray you, so long as you are a part of an institution, do not condemn it. Not that you will injure the institution—not that—but when you disparage the concern of which you are a part, you disparage yourself.

"More than that, you are loosening the tendrils that hold you to the nstitution, and the first high wind that comes along, you will be uprooted and blown away . . .—and probably you will never know why."

We are often too prone to speak of, or demand, our constitutional rights, or to say that we are entitled to private opinion. For your nformation, the following excerpt is quoted from A Pocketful of Pebbles, by Jan Struther:

> Private opinion creates public opinion. Public opinion overflows eventually nto national behavior, and national behavior, as things are arranged at present, can make or mar the world. That is why private opinion, and private behavior, and private conversation are so terrifyingly important.[1]

A careful analysis of the above will be of great benefit to all of us and will at the same time not deprive us of our private opinions so long as they *are* private opinions and not used as a subterfuge to stress our point and do harm to an individual or organization.

In our everyday work we must put aside our individual ideas and work for the good of the Service. REMEMBER—what is good for the Service is good for you.

If a particular deed is worthy of praise, it should be looked upon in the light of "WE;" by saying that "WE" accomplished this particular deed the entire organization will receive credit for its accomplishment. After all, we should strive to work together as one big organization, or team, instead of as individuals. Be careful not to develop the "I" complex.

Superiors should be quick to notice and offer praise for outstanding work. Experience has taught us that every person and group of persons will react to kind words and encouragement if properly given out in deserving cases.

PERSONAL APPEARANCE

Much of the success obtained in meeting the public will depend upon your personal appearance. It is not necessary that you be a "white collar dude" or that you appear in formal dress. Just remember to do the best with what you have. No one likes to hold a conversation with a ragged and unclean person. It has often been said that "Cleanliness is next to Godliness."

The occasion may arise when out of necessity you will be forced to talk with persons or strangers immediately after fighting a bad fire or doing a dirty job. Your appearance on this occasion may be explained, and the person you are talking with will understand the circumstances and make allowances for it. He will not, however, overlook your dirty appearance if you are in that state every time he meets you.

Some persons will judge you by the condition of your equipment. Keep your truck and other equipment as neat and clean as possible. REMEMBER—every citizen of the State of Florida has helped to pay for your equipment, and there will be certain persons who will try to find fault with it. Give them no cause for criticism.

---

[1] Printed with permission of Harcourt, Brace and Company and Reader's Digest.

MEETING THE PUBLIC

The Approach

There is only one way to meet and greet the Public—the RIGHT way. The RIGHT way will, of course, depend largely upon circumstances and the persons involved.

Meeting the person you know.—If you know this person's name be sure to call him by it. Experience has proved that every person likes the sound of his own name; he has had it since birth, and it is his oldest possession. His name seems to fall softly on his eardrums and leave him with the satisfied feeling that he has at least made an impression strong enough to cause you to remember who he is.

If you do not recall his name, don't try to bluff your way for he will soon learn that you are bluffing and will probably resent it. If you cannot remember his name and yet recall the occasion of your last meeting, then refer to this meeting and ask him his name. When he tells you his name, repeat it several times to yourself, and if possible associate it with some event or other thing which will enable you to easily recall it next time.

Refrain from addressing a person as "Brother." The individual you are addressing may not like you and would not want to be your brother, and in any case, the term sounds insincere and artificial. Nicknames should be used only where you know the individual well enough to take this privilege.

Meeting the stranger.—Remember, first impressions are sometimes lasting. You may be judged by your initial conversation or behavior and if it creates an unfavorable impression, you may never be able to convince your listener that you were not acting in your normal and usual manner. Also bear in mind that you represent the Florida Forest Service and the State of Florida. You are their ambassador: make them proud of you and endeavor to make the public respect you

The introduction.—Under all circumstances make your introduction as amiable and firm as possible. Approach the stranger in a businesslike but friendly manner, tell him your name and title, and make certain that he understands who you are. If you doubt that he clearly understands you, then take a few minutes to explain your duties or mission. After you are sure that he understands, start your conversation.

The Conversation

Your conversation will depend, of course, upon the circumstances at hand. If the person is already known to you, this should not be hard. If, on the other hand, the person is a stranger, make reference to his present activities after you have completed the introduction. Try to learn what the person is interested in and converse with him along these lines if you can intelligently do so.

If you are able to get the person talking about something he is interested in, you can later steer the conversation into other channels and probably learn what you want to know. Never dominate the conversation. If he should ask you questions, answer them in a truthful and understandable manner. Don't try to be sly or evasive.

If he should ask you questions which you cannot answer because of your lack of knowledge on the subject, don't try to bluff or guess your way through, tell him you don't know, and he will respect you for it. Wherever possible, tell him who may be likely to have the desired information. If you later learn of information that he wants, go back to him, if possible, and tell him about it. Don't make promises, however, that you can't keep. Always try to leave the person in a satisfied and happy frame of mind. If he should later find that you have given him a false answer, or have been bluffing, he will resent it and will probably judge your entire organization accordingly. You can learn more from listening than telling, and a few well-directed questions may get the other fellow started.

Profane and obscene language.—Many of us are prone to overindulge in the old American custom of swearing. We must be on guard at all times in an effort to eliminate this laxity. There are persons who strongly object to the use of profane and obscene language and are easily offended when it is used in their preseence. Certainly, everyone objects to its use if they are angry, or if the circumstances are such that they are at a disadvantage. Never direct this sort of language at persons, for nothing is proved or gained by its use, and it only tends to brand you as a foul-mouthed person.

Boisterous language.—A boisterous or loud-mouthed and noisy person is thoroughly disliked by everyone; and so is a braggart. In our enthusiasm over a particular subject, it is often easy to fall within this class. Be on the alert, and you will not be guilty of this practice.

Timidity and shyness.—This may on occasions be just as dangerous and damaging as too much conversation. Some persons have a reserve or "outer shell" which is often mistaken for timidity or shyness, but if you are one of these persons, try to overcome it. Avoid being a shrinking violet. Modesty is a virtue but can sometimes be carried to extreme. Don't try to be the "silent type." Don't be reluctant to engage in general conversations, especially if this conversation interests and includes you.

Accusations.—A person will dislike you if you accuse him indirectly of committing an offense. This is sometimes true where the person is directly accused, but at least it gives him a chance to defend himself. If you know of, or have reason to believe that a person is guilty of committing an offense, the wisest method would be to discuss the matter with that person and not with every Tom, Dick, and Harry on the highways and byways. The latter procedure will only serve to make him alert and enable him to build an alibi.

Even if you are certain that a person has committed an offense, discussing it with every person you meet will be of no value and will certainly not strengthen your case or cause in the final analysis. If your facts or evidence are true and complete, take disciplinary or legal action, whichever the case calls for. Don't be a gossip.

Keeping your temper.—Under no circumstances should you lose your temper; nothing can be gained in so doing. And always remember that a person who loses his temper is at the mercy of a cool opponent. There will be occasions when persons will deliberately try to "get your goat," or make you mad. Don't be a victim of this.

Arguments.—For every argument won there must be a loser. A prolonged discussion of differences in opinion will eventually lead to heated argument and usually proves nothing. Always remember that every person is entitled to his own opinion. You need not try to convince all others that only you are right. There are two sides, and sometimes more, to every story.

It is natural for persons to have different opinions. If a person's opinion or viewpoint is different from yours, you will seldom win him over to your side through argument. If you differ in opinion, never tell him bluntly that he is wrong. Merely tell him that he may be right, that in your opinion you see it thus and so. Remember, you are representing the State of Florida, and it will be for the best interest of all concerned if an argument is avoided. If for some reason you must show him that he is wrong, then it will be best to do so in a way that will allow him to feel he was at least partly right and thus save face.

Flattery.—Never stoop to flattery. Deserving persons will not expect it and others are not entitled to it. Certainly those persons who have accomplished some outstanding feat or act should be commended but this does not mean they are to be flattered. It has often been said that flattery is a poor substitute for proper and deserving praise.

Don't be a "Yes Man." This type of individual is repulsive to the majority. Be firm in your convictions, without argument, and it will be a great help in making others like and respect you.

Admission of error or fault.—Man is not perfect. He makes mistakes easily and often. Nothing is so difficult for some persons as to admit they were at fault. If you have made an error, or are at fault for any reason, be quick to admit it to the person or persons concerned. Don't be dramatic about it. Others will respect you if you pocket your pride and admit that you have erred.

If you are never hasty in making decisions or statements where they are not needed, there will be little likelihood that it will be necessary for you to admit error. A good rule to remember is, "Do not make unnecessary statements or decisions and it will not be necessary for you to retract them later." In this manner you will demand respect from others, and they will be more likely to believe the things you do say

THE DEPARTURE

Persons will remember you favorably and will extend a more genuine welcome on your next meeting if you have left them in a pleasant and happy mood.

Many of us are prone to use slang or pet farewells, such as "See you in church," or "Don't take any wooden nickels." These may, or may not, be out of order, but they have no particular meaning Wherever possible, try to give a farewell which will have a meaning will linger with the person, and will cause him to remember you pleasantly. Make your farewell sincere and sensible, such as "Hope to see you soon," or just plain "Goodby."

MAINTAINING CONTACTS

So many of us are prone to take our friends and contacts for granted As a result, these friends feel they are neglected unless we want to get something from them. This feeling often causes a rift in friendships; it is not helpful to goodwill and will not strengthen our cause

Whenever you can find the time, renew your contacts and acquaint-nces both old and new. Drop in on them occasionally and spend a ittle time in pleasant and interesting conversation. Never appear to e in a hurry. Sometimes a hurried contact or visit may do more arm to your cause than no contact or visit at all. But, don't be a uisance and wear your welcome out. Don't give others the impression you have nothing to do.

One of America's political greats once said that he maintained a ook with the names of all his voters; that this book contained infor-nation on his voters and their families, and wherever possible the ames of their friends, relatives, and families. The politician stated hat he studied this book carefully before each visit and tried to call nembers of the family by name, or to make reference to some incident which was pleasant to their memories. According to the politician, he results obtained were amazing and satisfying.

We cannot hope to set up a similar bookkeeping system for each of you, or to tell you how or when to call on your contacts, but at least the politician's procedure should help form a pattern for all of us.

Magnesium Wedges for Felling and Bucking.—The new magnesium wedges now on the market weigh only about one-fifth that of steel wedges of the same size and only slightly more than hardwood wedges. They combine the durability of the former with the lightness of the latter; thus, they should be superior to both as a fire tool wherever weight and dependability are factors.

We have subjected them to a trial of physical tests to determine whether this premise is correct.

Using a 1-pound magnesium wedge, which compares in size to the 12-ounce hardwood wedge and the 5-pound steel wedge (10-inch length), we found it adequate for normal bucking and felling use. In fact, it withstood hammer blows that quickly shattered wooden wedges. With severe abuse, the magnesium wedge can be distorted or shattered more readily than steel, but this abuse was far greater than what should occur on the job. We could produce no "mushrooming," but the magnesium did chip with repeated, deliberate, glancing blows. From a safety standpoint, however, we judged the extremely light metal to be relatively harmless as compared to flying steel. It was our conclusion that, with proper use, the magnesium wedge should have a lengthy life. We believe it to be the tool to use on any bucking or felling job where there is any degree of packing to be done.

Magnesium wedges are now available in a variety of bucking, felling, and power-saw patterns. At present prices they are about 10 percent more than steel and about three times the cost of hardwood wedges.—Walter J. Puhn, *Forester, San Bernardino National Forest.*

Rust Prevention for Milk Cans.—In using the 10-gallon tinned milk cans to transport and store water for fire camp use, it is necessary to keep them clean and dry at all times, especially when they are stored for future use. Any moisture, even that moisture resulting from condensation caused by changes in air temperature, will cause the cans to rust.

If a piece of zinc about 2 inches square is soldered on the inside of the bottom of these cans, rust on the bottom of the cans will be eliminated. However, no liquid containing an acid can be put in the cans and they should be marked accordingly. Using the zinc plate in conjunction with inverting the lidless cans while they are not in use has considerably increased their life on the Cleveland National Forest.—Fletcher Hayward, *District Ranger, Cleveland National Forest.*

PROGRESSIVE HOSE-LAY IN FIRE SUPPRESSION

Stanley R. Stevenson, *Fire Control Officer, and* Edward W. Schultz, *Assistant Fire Control Officer, Cleveland National Forest*

A reanalysis of fire control requirements made in 1946 indicated that 70 percent of all fires on the Cleveland National Forest since 1934 (beginning of expanded tank truck use) were controlled at a perimeter of 20 chains or less through the use of tank trucks. This record of effectiveness of the use of water in fire suppression is further substantiated by regional studies. This reanalysis showed that three to five men with power water equipment controlled 5 chains per man-hour control time. This record of control was accomplished under conditions of maximum heat per unit of perimeter. The rate of perimeter control is 15 to 20 times greater than that of similar perimeter units where hand tools were used in line construction.

With this fact as a basis, we proposed to develop a means of placing water over a large and increasing perimeter of a hot brush fire with the same efficiency by expanding the crew.

Preliminary developments determined the problems to be solved in a practical application of the proposition as those of:

1. Organization.—An organization will be required that can function smoothly and fast. This demands that men, whose major experience with the use of water lies in initial attack suppression problems, be trained to operate as a large team on a hose-lay operation where the success of each phase is dependent upon every man.

2. Water supply.—A continuous supply of water must be available to the operation. This recognizes the present inadequacy of source of supply of tanker loads and the limitations of elevation upon delivery of water to a fire.

3. Equipment.—Efficient and modern power water equipment and large amounts of hose, hose-lay fittings, portable pumps, and accessories are needed. Original development of practictal aids will be required as problems are encountered.

4. Strategy.—A determination must be made as to what type of suppression problem the operation is adapted as limited by topography, cover, major sources of water, and burning conditions.

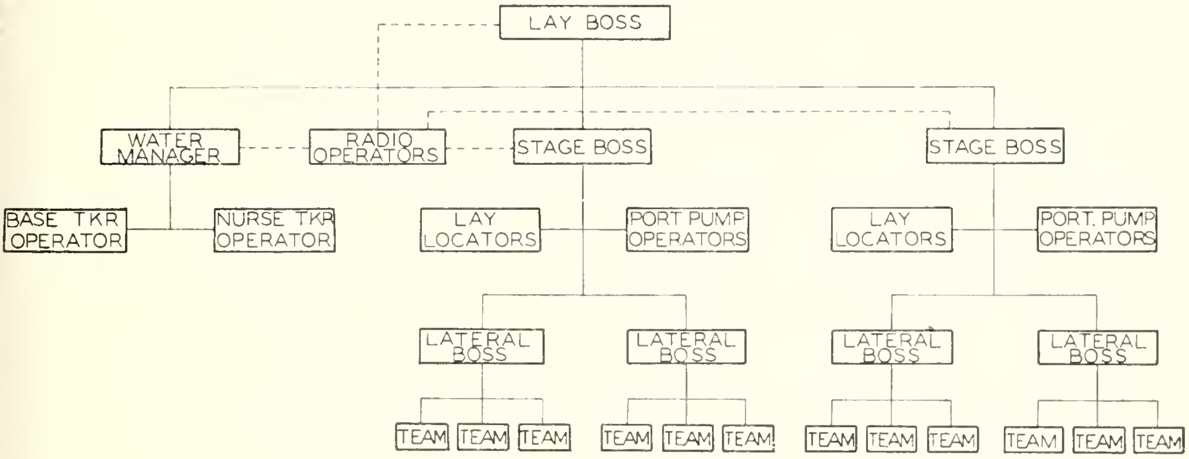
Toward the solution of these recognized problems, a preliminary plan of operations was made and executed in a 2-day meeting of experienced fire control men on the Cleveland National Forest. At this time, 1,500 feet of main-line 1½-inch hose with 100-foot 1-inch laterals every 200 feet, was laid by 7 men in 50 minutes; 2,000 gallons of water was used at an average of 10½ gallons per minute at each nozzle. No progression of manpower was made beyond the point where brush was wet enough to assume theoretical control. Water was available to all laterals, the base pumper being refilled by "nurse" tankers relaying water from natural sources.

The trial gave a control rate of 4 chains per man-hour, approximately the same rate as shown by initial attack tanker crews on small perimeters. The fact that good results were obtained with available equipment and little experience indicates the practicability of the operation.

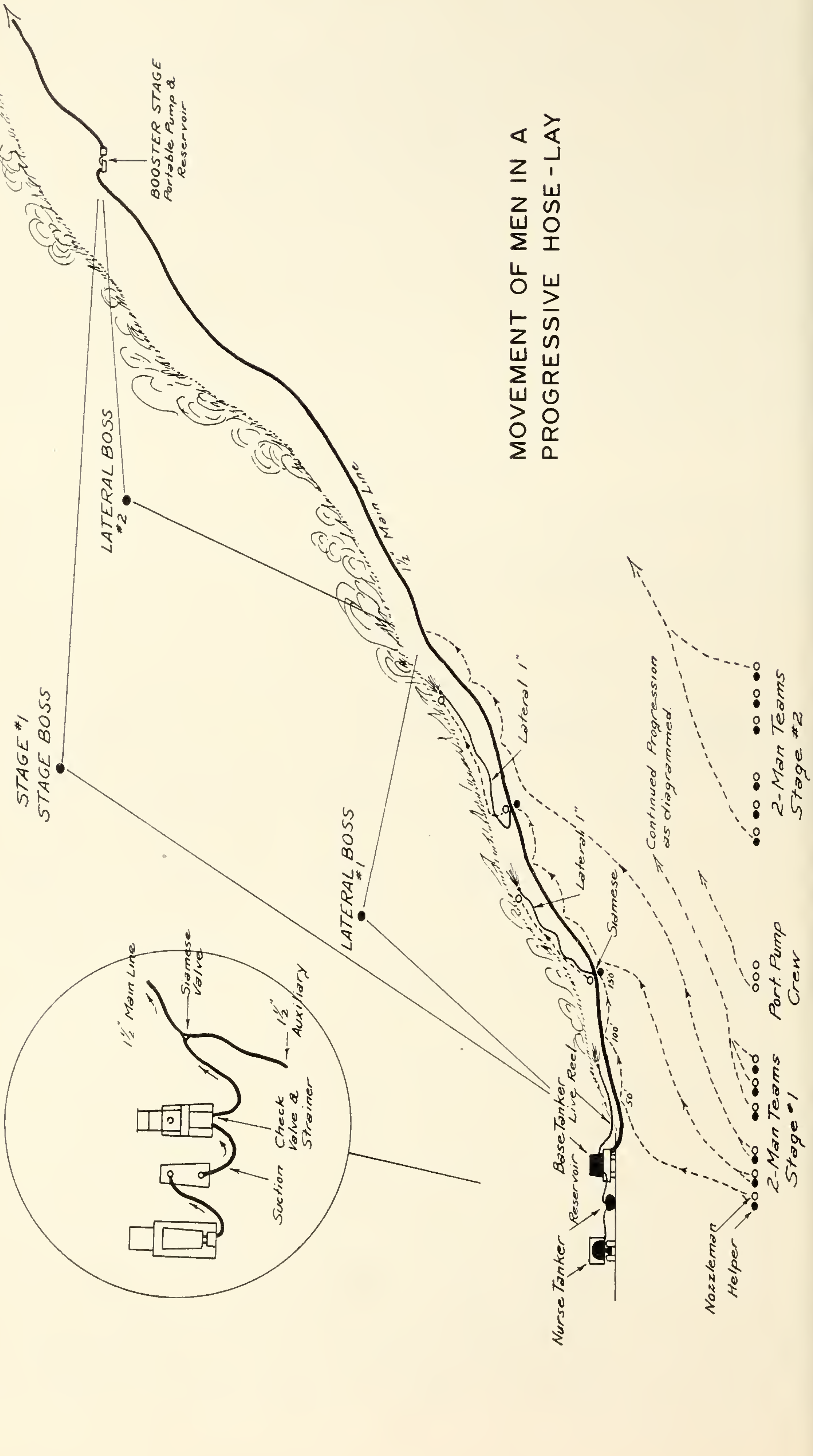
We have called the operation a "progressive hose-lay" and the control line created by it a "water scratch-line." It is fully recognized that this line is a temporary, fast, control line achieved only through progressive application of water to the growing fire perimeter, with control maintained by the lateral lines installed during progress. This line must be followed up with hand line construction to achieve complete and safe control. The hand-constructed line can progress directly on the fire edge with greater speed and without danger and fatigue from heat to the crews. The basic advantage of the progressive hose-lay is the ability to make direct attack on hot line with speed and safety, resulting in faster control. There is also a psychological stimulus to fire fighters in using water in fire suppression.

ORGANIZATION

The organization as shown was developed from trials and use on actual fires. It may be compared to a division organization on a large fire with suitable titles adapted to positions on a hose-lay. It may be expanded or reduced to sector, division, zone, or fire as necessary.



It is possible to place a team organization of this type on both flanks of a fire, progressing to tie in at the head. The lay boss (division boss) is responsible for the operation of one entire hose-lay of any length which has two or more water boosting stages. It is his general function to manage and coordinate all elements of the lay. The stage boss (sector boss) directs the laying of one stage. A stage is that length of hose-lay up to an elevation at which the lower pumping unit is limited in its water output by elevation or number of laterals. He is responsible for determining this point and providing a booster pump for continuation of the progressive hose-lay. The stage boss has several lateral bosses (crew boss), each in charge of three or more laterals as the problem demands. They are responsible for the smooth progression of their teams through the hose-laying procedure. As the size of the job to be done dictates, positions of water manager to coordinate base supply tankers and nurse tankers, lay locators to cut way-trails, lay inspectors to check for leaks and breaks in lay, and others may be added.



MOVEMENT OF MEN IN A PROGRESSIVE HOSE-LAY

As in the performance of a football play, this organization must be keyed by men who know the progressive movements of its operation. When the initial attack crew recognizes that immediate control is not possible with available equipment and manpower, the scheme of progressive hose-lay begins with the decision that such an operation is adaptable to the suppression problem. Without waste of time on the usual lost efforts, they can initiate a main line lay and laterals with the hose and accessories available. Reinforcement crews provide additional water, equipment, and manpower to continue the progress of the lay around the fire edge. The Cleveland Forest has equipped a stakeside on each district with a large water tank and pump to provide the immediate need of a large volume of water, hose, and fittings to first reinforcements.

In the event of fast burning conditions continuing the increase of perimeter, fast dispatching of large reinforcements of manpower and equipment are necessary in Southern California cover types. Upon arrival of reinforcements on a fire reaching major proportions, with a control on the flanks initiated by the first crews, some men are placed in the organization to continue progressive water suppression to a point of control or tie-in with other operations. This procedure was successful on the two class C and two class E fires on which it was operated during the 1947 season on the Cleveland National Forest.

In the diagram the team units, consisting of two or three men, are the hose layers. A team starts their lay of 150 to 300 feet by connecting to the siamese valve at the end of the controlled portion of the fire perimeter. The 100-foot lateral at this point continues along the flank, knocking down the fire and making a water scratch-line. The team is able to lay their main line under the protection of this lateral. When they reach a point where the last lateral cannot protect them, they loop 50 to 100 feet of main line to the rear and install a siamese valve and lateral. The man on the last siamese valve is signaled for water by this team and as the nozzleman of the team receives water at the nozzle, he proceeds ahead continuing the water scratch-line. Manpower coming behind straightens the charged lines out as the nozzleman progresses. This procedure continues with additional teams carrying on in the same manner. Each team, upon completion of their lay, remains on the lateral, holding the fire edge and checking their lay for protection against hot spots. As soon as possible, they shut down and use water only for hot spots and flare-ups to maintain control of their line.

As the fire edge becomes cooler through the efforts of the lateral team and their siamese valve has given water ahead, the nozzleman can maintain control alone and the others return for more equipment to form another team.

Training of personnel for this operation is not one of the big problems. The coordinated progressive movement idea is mastered quickly. The key positions must be filled by men who understand the basic principles of hydraulics as related to hose-lays and are able to calculate and prepare for the limitations of equipment in moving water from point to point, up and down. If key positions are filled by trained men, completely inexperienced men can be used for laying hose with very little prior instructions.

EQUIPMENT

The trials and actual fire experience with equipment for this operation indicate that available equipment, with some adaptions, is adequate. For the base pumper operation the R–5 demountable tanker (Green Hornet) is the most efficient. It is desirable to install a shut-off valve on the 1½-inch outlet to prevent loss of water column in case of shut-down. A siamese valve with necessary adapters on the end of the first length of main line, installed backwards to provide an emergency switch-over to another pumper, is used successfully when the base tanker breaks down or needs servicing after long periods of pumping. This is necessary to maintain the uninterrupted flow of water to the main line.

Stakeside 1½-ton trucks with a 400- to 600-gallon tank and pump are used for nurse tankers; 425-gallon airplane wing tanks, made of rubber and canvas ply, anchored to the bed of the truck are also very successful. They have numerous outlets and with little work can be fitted with a pumping arrangement. These nurse tankers carry an additional empty wing tank, extra hose, siamese valves, nozzles, and a portable pump booster stage set-up. The extra wing tank is rolled off beside the base tanker for a reservoir. This reservoir is kept filled by relay nurse tankers.

The portable pumper stage set-up is available for boosting stages when the hose-lay has reached a point to which the last pumping unit cannot lift sufficient volume of water. It consists of a pump, packboard, canvas reservoir, and accessories. The fittings include a check and a bleeder valve and pressure relief valve.

Team pack units have been devised to solve the problem of men having their hands free to aid teams laying hose and proceed through brush without wrestling with rolls of hose and accessories. Each team has a packboard with separate ties for carrying three 50-foot lengths of 1½-inch CJRL hose and a packsack containing two 50-foot lengths of 1-inch CJRL hose, a siamese valve, and a nozzle with extra tips for the lateral installation.

The 1½-inch hose is double-rolled with male connector lapped by the female connector and double-tied with a one-pull release tie. The 1-inch hose is rolled by starting two separate rolls, side by side, from the middle of the length and tied in the same manner.

The most efficient siamese valves used are those with a single handle, well labeled, and equipped with an inverted cone type, self-releasing central control valve. They are carried with one 1½-inch to 1-inch adapter for the lateral line.

The recently developed Forester Fog Stream shut-off nozzle with its selective control over two streams is very efficient due to its light weight, compactness, simplicity, and double feature of water delivery. In using these nozzles, an in-the-line strainer is used at the base tanker and at intervals along the main line to prevent the fog outlet from becoming clogged with foreign material.

Continued use of the progressive hose-lay for fire suppression will determine the most adaptable equipment and create numerous aids toward its effective operation.

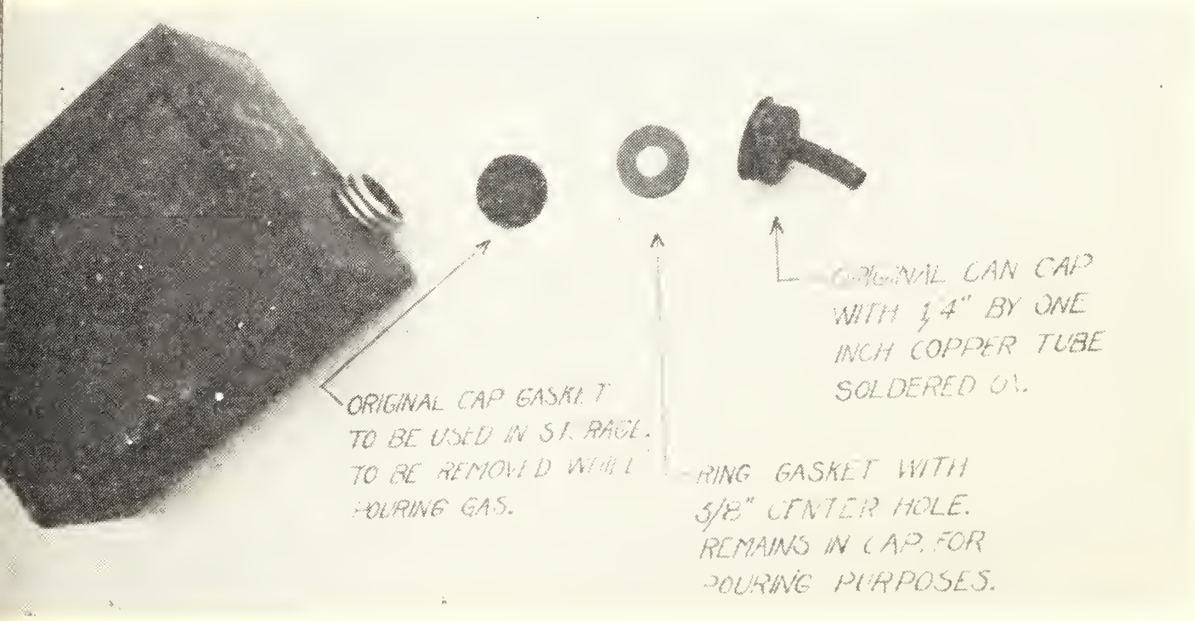
RESULTS ON TRIALS AND FIRES

The accompanying table shows the results of instances in which the rogressive hose-lay was used during the 1947 season on the Cleveland ational Forest.

Item	Trial 1	Trial 2	Fire 1	Fire 2	Fire 3
ze ... acres	...	...	10	623	90
erimeter ... chains	...	...	60	150	200
otal perimeter controlled by progressive hose-lay ... percent	...	...	100 + spots	20	15
ength of lay ... feet	1,500	2,700	1,200	5,000	2,000
lapsed time of lay ... hours	.8	.8	.5	2.0	1.0
en on lay ... number	7	36	10	15	27
erimeter per man-hour ... chains	4.1	1.1	12.0	3.0	1.1
aterals installed ... number	7	18	3	17	14
ater pumped ... gallons	2,000	5,000	4,200	12,000	10,200
ifference in elevation ... feet	+300	+340	Level	+350	+320

Trial 1 was conducted by experienced fire control personnel accounting for the higher rate per man-hour as compared to trial 2 which was onducted for training inexperienced men. Fire 1 was a long narrow ire on which both flanks were controlled by the same laterals. Fire 3 esults were attained by an organized "hot-shot" suppression crew ho had received only 3 hours training in the operation on the morning of the day the fire occurred. The lay was made up a 65 percent lope covered with very dense brush where hand crews had withdrawn ecause of heat and danger.

Funnel Attachment for 1-Quart Gasoline Can.—The accompanying photograph hows a device that materially increases the usefulness of a 1-quart gasoline can or filling Coleman lanterns.



Safety rules prevent venting the can. With the funnel and gasket attachment, pressure can be applied to the sides of the can making in a "squirt" can. Anyone who has tried to fill lanterns without the funnel attachment will appreciate the improvement.

The spout can also be partially plugged to apply kerosene on crosscut saws.—Cleo Anderson, *Assistant Ranger, Cibola National Forest.*

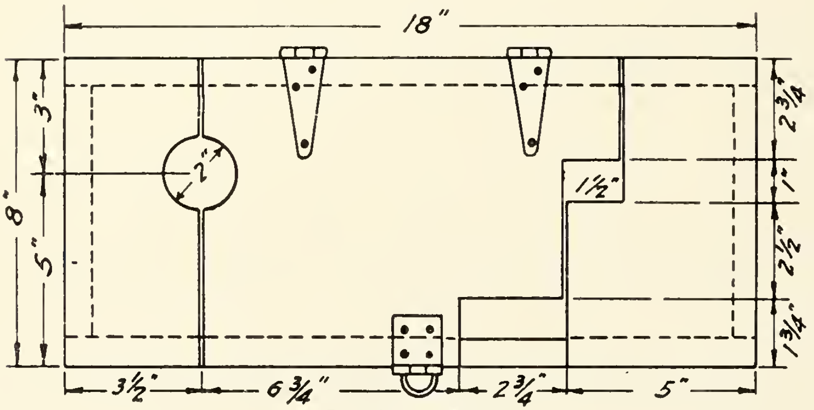
TOOL BOX FOR FELLING OUTFIT

JAMES E. TAYLOR

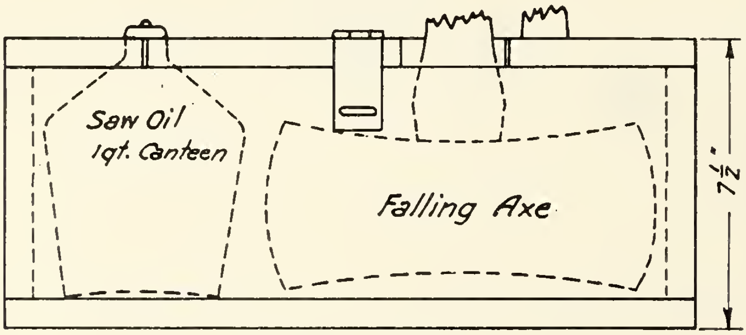
Fire Control Assistant, Stanislaus National Forest, U. S. Forest Service

A safe practical box for storing and transporting a felling outfi was designed and constructed on the Calaveras District, Stanislau National Forest, Calif. The box, which holds all of the necessar equipment except the saw and hard hats, is 18 inches long, 8 inches wide and 7½ inches deep. The saw and hard hats are kept with it in th warehouse and are shipped to fires so all will arrive at one time and i good working order.

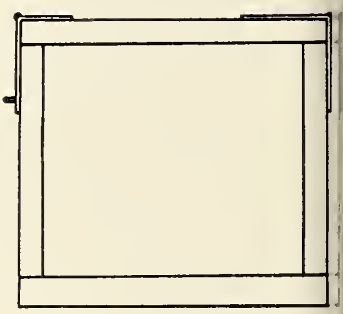
The dimensions of the tool box and method of tool arrangement ar shown in the diagram.



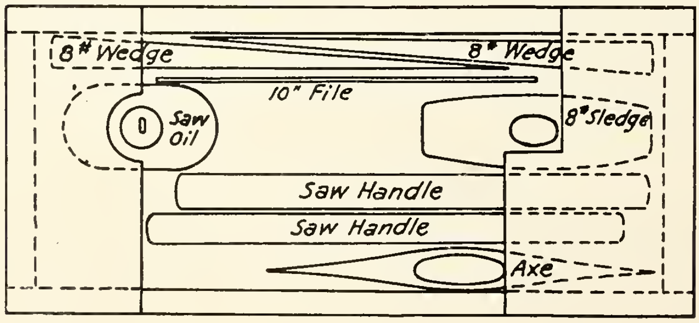
TOP VIEW



FRONT VIEW



END VIEW



TOP VIEW
showing
TOOLS IN BOX

FOAM

A. B. Everts

Fire Staffman, Snoqualmie National Forest, U. S. Forest Service

The intriguing characteristics of foam—its rapid expansion rate, ts clinging and insulating qualities, as well as its spectacular performance on shipboard and oil-tank fires during and since the war years—stimulate the imagination as to ways and means of how this fire extinguishing agent can be efficiently applied to forest fire control. Manufacturers of foam and foam equipment have, for the most part, given little or no thought to the problems of forest fire agencies. There is a dearth of literature on the subject. D. P. Godwin, in the December, 1936, Fire Control Notes, reported a series of tests on the Monongahela National Forest which pointed out some of the values of foam. T. R. Truax, in the October, 1939, Fire Control Notes, reported the results of further field tests conducted by the Forest Products Laboratory.

However, the rather cumbersome methods of producing foam and the equipment needed, as in the one-powder, the two-powder, and the two-solution methods reported by Godwin, if not obsolete, have at least been greatly simplified by industrial research since 1936. While the author has nothing new to offer as to the practical value of foam in forest fire control he has had the opportunity to experiment with mechanical foam in back-pack cans, tank trucks, and pressure units. The method of application is simple. It remains for field tests to determine the value.

Types of Foam

The two principal types of foam are chemical and mechanical.

Chemical foam is a powder which is introduced into the hose line by means of a hopper or generator approximately 100 feet back from the nozzle. While equipment for its use has improved since 1936, the method of application is essentially the same as that described by Godwin. The quality of the foam is excellent but the employment of a hopper on an advancing fire line creates obvious disadvantages: the hopper must be moved along as the line advances and additional manpower is needed to pack the powder to and keep the hopper full. Other disadvantages are that the nozzle cannot be shut off, since to do so causes the water to back up in the hopper and force the powder out. Chemical foam is not as free flowing as mechanical foam and for that reason seems less desirable.

Mechanical foam is a liquid with a soybean base and other ingredients. It is dark in color and evil smelling, but unharmful to the skin, clothing, or painted surfaces. It can be used with either fresh or salt water. The writer believes mechanical foam offers the best possibilities for forest fire work and, for that reason, the rest of this article will be confined to its use alone.

Cost of Foam

During the war the cost of foam to the Navy was said to be $11.50 per 5-gallon can. Since the war many hundreds of cans have been sold at $1 and some as low as $0.50 on surplus property sales. At this time the price seems to have stabilized at $22.50 per 5-gallon can. At this price few protection agencies can afford to use it except on those infrequent fires where its use will pay off. Even at this high price, however, which works out at approximately 2.2 cents per gallon of foam produced, it is a matter of record, as we shall see later, that 400 gallons of foam has been responsible for saving at least one and probably three dwellings from burning to the ground.

Characteristics of Foam

The characteristics of foam, which stimulate the imagination, are:

Expansion.—The rate of expansion varies with the pressure and size of the nozzle used. Foam can be produced with as little as 30 pounds pressure but best results are secured at 100 pounds. At 100 pounds pressure, the rate of expansion is approximately 10 to 1. The foam solution is mixed with the water at the rate of 6 gallons of solution to 94 gallons of water, and this mixture will produce about 1,000 gallons of foam.

Delivery.—The gallons-per-minute foam delivery also varies with the pressure and size of nozzle used. Delivery of up to 300 gallons per minute can be secured from 1-inch hose lines and up to 600 gallons per minute from 1½-inch hose lines. Thus a small fire can be quickly covered with a thick foam layer, blanketing out the oxygen.

Insulation.—The clinging characteristic of foam enables one to insulate logs, short snags (40 to 60 feet, depending on the nozzle used), buildings, and other material from the flames. The foam will stand up for an hour or more. The value of this property can best be illustrated by quoting from "The Use of Fog and Foam by Small Fire Departments" by Walter W. Stephen in the January 1946 issue of Fire Engineering. This articles states:

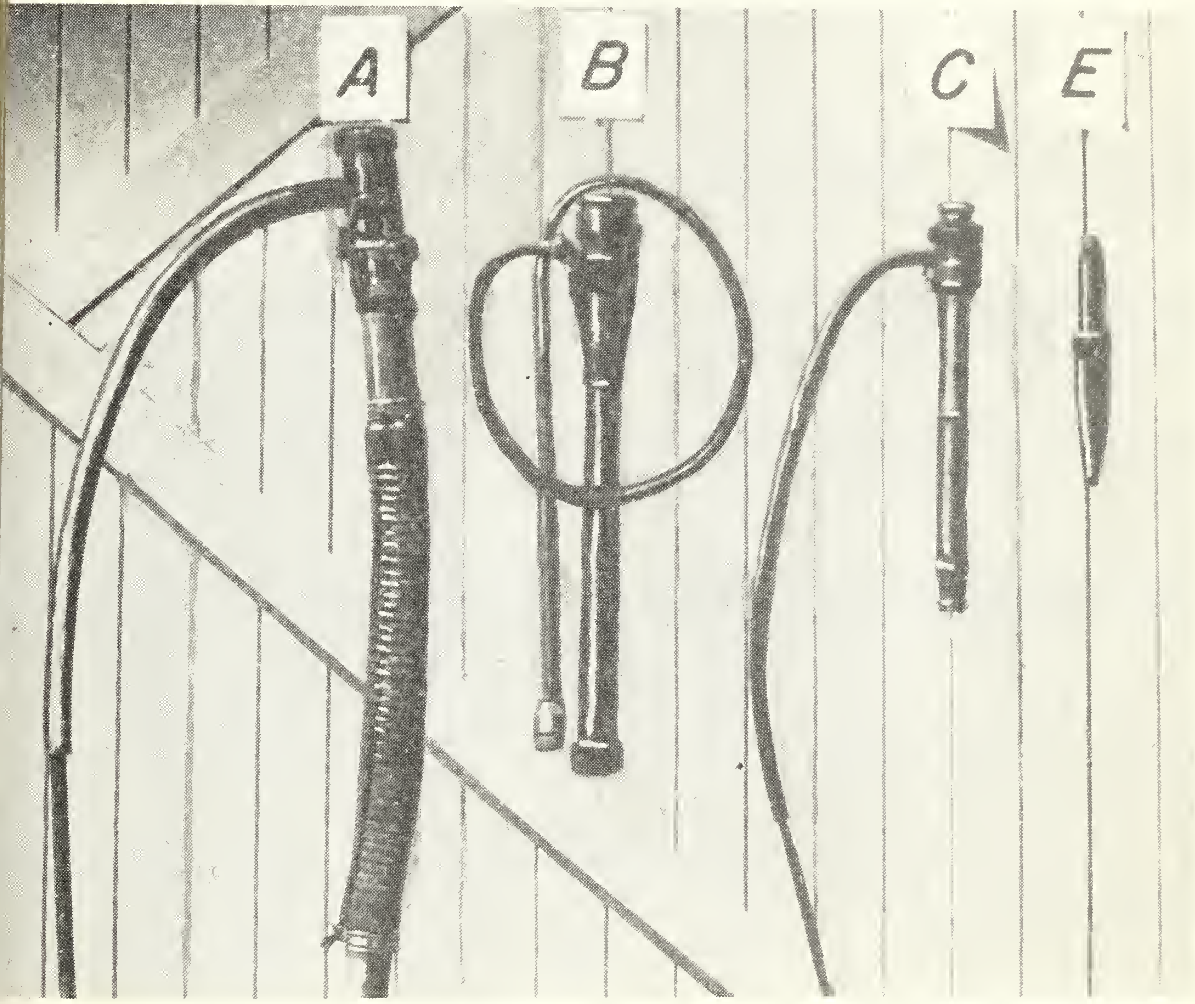
> A hose and chemical truck from an industrial plant went 4 miles out into the country to a crossroads community in response to a phone call. It was found that a fire, starting at one end of a row of five small one-story, frame, shingle-roofed dwellings, had involved two and seemed certain to destroy all of them. There was no source of water nor any apparent way to fight the fire.
>
> There was, on this piece of apparatus, a 40-gallon foam extinguisher. This was operated, and covered the exposed side and half of the roof of the third house with foam; these surfaces were scorching and smoking and about to "light off." The blanket of foam remained in place and protected and saved this house and the other two dwellings beyond it, while the first two that were on fire burned to the ground . . ."

At an expansion rate of 10 to 1, the 40-gallon extinguisher would have produced 400 gallons of foam. It seems very unlikely that these three buildings could have been saved with 40 gallons of water alone.

Methods of Introducing Foam Into Hose Line

There are several methods of introducing mechanical foam into the hose line.

Pick-up tube.—Four different sizes of nozzles are shown in the accompanying photograph. The first three have pick-up tubes. These are simply Venturi tubes designed to pick up the mechanical-foam solution at the proper proportion. The tube is inserted into a can of solution, and the movement of the water through the nozzle draws the solution into the base where it is mixed with air and water and thus produces foam. The disadvantage of this method is that, like the hopper used with chemical foam, cans have to be carried along the advancing fire line.



Nozzle *A* produces 540 to 600 gallons of foam per minute, using water at the rate of 56 and solution at 3.6 gallons per minute. Nozzle *B* produces foam at 300 to 500 gallons per minute. Nozzle *C* uses 15 gallons of water to produce 150 gallons of foam per minute. Nozzle *E* takes 2 gallons of water to give about 17 gallons of foam per minute; used on a back-pack can, this nozzle produces 32 gallons of foam with one quart of foam solution and the rest water.

Pick-up at the pump.—This method calls for special equipment and introduces the liquid on the suction side of the pump.

Pressure proportioner.—The proportioner comes in two sizes with capacities of 20 and 50 gallons respectively. Both sizes are dual compartmented so, while solution is being used from one compartment, the other one can be filled. Chief Ranger Rose of Mount Rainer National Park, a former Coast Guard officer, has mounted one of these proportioners on a tank truck and uses it for building protection.

Premix solution.—The fourth method is to mix the solution at the rate of 6 percent with the water in the tank truck. The pick-up tube can then be removed from the nozzle, as is also the case with the proportioner method. The disadvantage of this method is that once mixed the foam has to be used. Since foam will not be used on every fire on which a tank truck makes a run, it is obvious at once that this method is uneconomical. A fifth method is, therefore, suggested for use with tank trucks.

Pressure premix.—Experience has shown that either carbon dioxide (CO_2) or nitrogen gas is a good pressure medium for handling liquids. A light-weight pressure tank of desirable size, 18 gallons for a 300-gallon tanker and 30 gallons for a 500-gallon tank truck, could be mounted in any convenient location on the truck. This tank would hold pure foam solution. From this tank a 1-inch perforated pipe would run the length of the water tank. Connected to the foam tank a cylinder of CO_2 or nitrogen would furnish the pressure to quickly mix the foam solution and water. A pressure gage or pressure relief valve, preferably both, on the tank would provide safety. With this arrangement, a tank truck could quickly convert to foam whenever it was desirable to do so.

The 150-gallon-per-minute nozzle operates from ¾- or 1-inch hose lines and uses 15 gallons of water per minute. Note the insulating and clinging characteristics of the foam produced.

Foam Nozzles

No one has yet designed an adjustable foam nozzle. With the pressure premix method an adjustable nozzle could be used. Otherwise, one must choose the nozzle best suited for the job at hand. This would mean a tanker would need to carry several sizes, a large nozzle for building protection and heavy fuels, a smaller one for light fuels. Even nozzle *C* produces foam too fast for effective application on light fuel such as grass and pine needles. What seems to be needed for this fuel type is a nozzle of about 50-gallons-per-minute capacity. Such a nozzle would consume 5 gallons per minute of water. A 300-gallon tank truck would then operate for 1 hour while producing approximately 3,000 gallons of foam.

Fog-Foam

Fog-foam is produced by passing mechanical foam through a fog nozzle. In this case, the air is mixed with the foam-water solution by the impingement of the fog streams. Contrary to what one might expect the foam is not broken down. The rate of expansion is not 10 to 1, but more nearly 2 to 1. In other words, the capacity of a tank truck is about doubled. The advantage of fog-foam is that it offers the same personnel protection as fog. Its principal use is on airport crash fires and on fires involving volatile liquids. The Navy uses it in sprinkler systems in some cases. Used on light fuels there seems to be no question but that it is more efficient than fog alone. However, there is no proof that it is any more efficient than water fog reinforced with a wetting agent and certainly the latter is much cheaper.

Foam Equipment

As previously stated, manufacturers of foam equipment have given little thought to the forest protection agencies. The equipment that has been built is of a special nature designed for a special purpose. For example, at Midway (between Tacoma and Seattle) a group of citizens have had designed a 150-gallon trailer pressure unit. Pressure is furnished by CO_2. A Y provides two 1-inch hose lines. One line uses fog and the other foam (with the pick-up method). This unit is already credited with having extinguished six fires.

The White River Lumber Co. of Enumclaw, Wash., has a speeder unit also CO_2-pressured and using foam. The tank has a 40-gallon capacity (400 gallons of foam). It is used for patrolling behind logging trains.

This company is now building two 100-gallon CO_2-pressured foam units. These will be heavily reinforced with railroad steel and provided with slings. They will be spotted at skidder settings. If a fire starts at the back end of the operation, they will be hooked on to the skyline and run back to the scene of the fire. Each unit will have 500 feet of 1-inch linen hose and a 150-gallon-per-minute foam nozzle equipped with a shut-off.

Other Possibilities

The writer has proved to his own satisfaction that it is possible to lay a foam line from a moving tank truck, and to backfire this line all in one operation. However, from the economic standpoint it is not feasible. It takes about 1 gallon of foam per linear foot in light fuels. Thus a 300-gallon tank truck could lay only about 3,000 feet of line. The same thing can and has been done with fog and the distance is more than tripled without adding the cost of the foam solution. Application for patent on the latter idea has been made.

And while we are speculating, another idea presents itself. It is not impossible that the future will see helicopter foam tankers. Such a unit might work as follows: The helicopter will take one or two men into a fire. After landing them, the pilot will return to the nearest road where, by prearrangement, he will meet a tank truck. He will land and fasten a canvas reinforced tank to his landing gear. This tank will be filled with water and foam in proper mixture. There will be 250 feet of plastic or linen hose equipped with a foam shut-off nozzle. The helicopter will then return to the fire. The hose line will be lowered and the machine rise to 200 feet. This altitude will be sufficient to provide about 100 pounds nozzle pressure. The ground men will then apply the foam to the fire. Or perhaps water-fog and a wetting agent will be just as effective.

Summary

In conclusion, then, we see that in discussing foam we must not overlook fog, especially wetter water fog. Each type of extinguishing agent has its place. It is a matter of knowing your equipment and what it will do. It should not be too far out of line to say that, considering cost, foam should be of value for:

(*a*) Back-pack cans where the addition of foam solution will produce 32 gallons of foam.

(*b*) Those agencies which, in addition to forest fires, are also charged with the responsibility for rural building protection.

(*c*) Agencies which operate along heavily used truck highways where the danger of large gasoline tankers catching fire can be expected. Fog will handle gasoline fires only if the entire burning area can be covered with fog, or in enclosed places where the effect of the steam produced aids in extinguishment. Foam, on the other hand, can be made to flow over the burning gasoline and bring about control.

Support for Canvas Relay Tank.—The portable tank used in relaying water from one pump to another can be made to stand alone by using one end of the standard folding canvas cot frame. By removing one end of the cot, leaving the other end and the middle legs, two sides and the uprights are formed. The other two sides of the frame can be made from the two end braces by trimming them flush with the sides. The framework folds and can be placed inside the tank before it is folded for storage.—RICHARD RAYBOULD, *Fire Crew Foreman, Cleveland National Forest.*

/olume 9 Numbers 2 and 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Address Division of Fire Control
Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1948

Contents

Pag

Fire line safety
Seth Jackson

Well's tree-marking gun and back-firing torch—explosion hazard tests
Division of Fire Control

The helicopter—Bell model 47B
Ira C. Funk and Fred W. Milam

Plastic for Osborne fire finder map covers 1
Stanley Stevenson

Observations on four prescribed fires in the Coastal Plain of Virginia and north Carolina 1
Kenneth B. Pomeroy

Portable hose coupling expander 1
William M. Sherman

The disk-dozer 1
H. M. White

Suggestion to facilitate fire sign posting 2
Division of Fire Control, Region 4

Consolidated fire organization chart and dispatcher's board 2
Fred G. Ames

Fire damage appraisal 2
J. A. Mitchell

A helicopter in fire control 3
T. A. Bigelow

Multipurpose tractor-drawn trailer and slip-on pumper tanker 3
R. A. MacIntyre and George L. Bouck

Sound economy on fire suppression 3
S. A. Nash-Boulden

The Coeur D'Alene air detection plan 3
Ralph L. Hand

Firefog unit 3
A. B. Everts

Report on a wetting agent: Drench 4
Louis Tauch

Modifying the Army insect sprayer (model 3264) for use as slip-on pumper tanker on ½-ton pick ups 4
Stanley R. Stevenson

Headlamp modifications required for use of metal clad batteries 4
Ira C. Funk

Misuse of the fire danger meter 4
Arnold A. Buettner

Forest smokechaser—a Region 4 fire film 5
J. W. Mattsson

Protection of tool handles from the powder post beetle 5
Fred G. Ames

Progress of recent equipment development 5
Equipment Development Committee

Fire camp wash rack 6
K. McDonald

FIRE LINE SAFETY

Seth Jackson

Administrative Officer, Washington Office, U. S. Forest Service

Probably nothing short of war is potentially more risky to life and limb than fire on the rampage. Miramichi, Peshtigo, Phillips, Hinckley, Baudette, 1910, Cloquet, Maine—these are names of spectacular forest fires. They resulted in many deaths and untold injuries to the public at large.

Less spectacular are the smaller fires which year after year maim or kill men fighting them—less spectacular, but just as serious to these men and their families. Besides the personal suffering, these injuries cause a large economic loss; loss of pay to the worker while he is off the job; medical and hospital bills to the employing agency; damage to equipment and material; and many indirect losses such as decreased production and lowered morale on the fire line.

Experience in the Forest Service shows that about a third of its injuries and deaths come from fire control activities. In addition to the 11 men killed as a result of Forest Service fires in the past 2 years, at least 25 men have been killed on State or private fires.

How do fire fighters get hurt? In fire fighting the two basic causes of most accidents—unsafe working conditions and unsafe acts—are always exaggerated. Take the case of the man who cuts his foot with an ax, one of the most common injuries on the fire line. The unsafe condition could be an ax in poor shape, poor footwear, poor footing, not enough area cleared for ax swing; the unsafe act, standing too close or too far from whatever is being cut, striking a glancing blow.

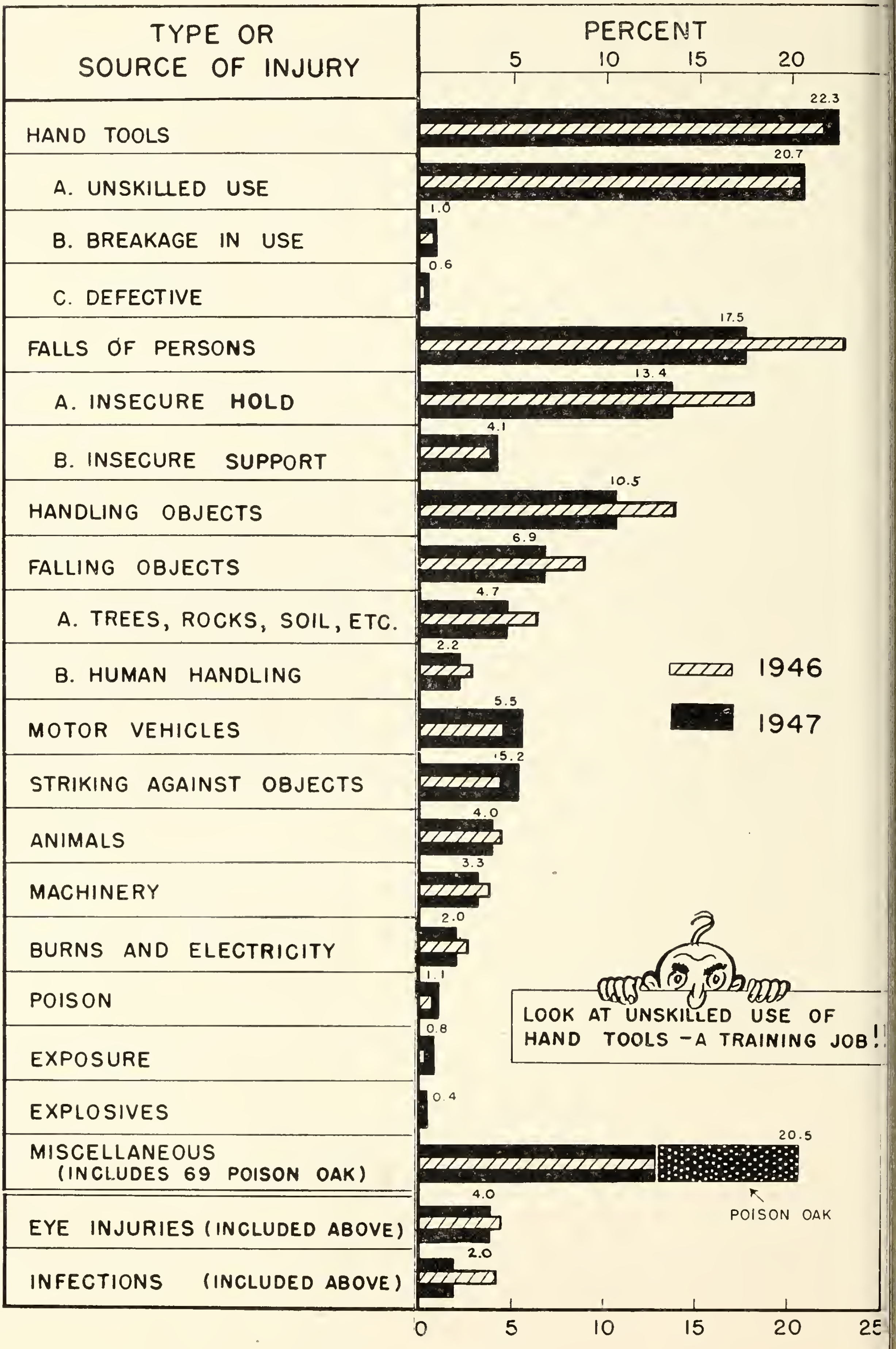
Another frequent cause, also a combination of condition and act, comes from slipping, stumbling, falling. Many cases of men being trapped on fires are attributable to this. Rolling rocks, logs, falling trees or branches—falling objects—result in many injuries and deaths. Less frequent but usually very serious are injuries due to machine equipment, such as jeeps, trucks, tractors, or bulldozers, getting out of control. The trend toward mechanization in fire fighting will increase the severity of this problem.

Land planes, seaplanes, and helicopters are going to be used more and more. Here carefully developed accident prevention plans will help to make the fire fighting game less exhaustive and safer. The helicopter especially shows great promise this way.

Curiously enough, no Forest Service smoke jumper has been killed on the job. There have been only 134 lost-time injuries on the 7,407 jumps made since 1943. Wind, an unsafe condition, played an important part in these injuries.

In general, fire-injury causes are similar to those indicated in the chart for all Forest Service work.

The accident situation is aggravated in fire control by several factors. The job is done under emergency conditions where minute count and safety is often lost sight of. Large numbers of "gree hands" must be put to work promptly without the benefit of experienc or training in woods work. Under these conditions some accidents ar inevitable.



Injury type analysis.

But the accident toll depends on what we do to keep it down. Four ourses of action are necessary to eliminate those unsafe working onditions and unsafe acts which are basically behind most accidents.

First, of primary importance in any safety campaign, *enlist the full upport of top management.* In fire suppression this means the demonstrated interest and active participation in accident prevention by all vork supervisors, from Division Chief and fire bosses to straw bosses. Workers will do what their bosses want them to do. The bosses must et the example.

Second, *include safety in all fire planning.* If safety is set up as a eparate job to be done when time permits, the chances are it will be overlooked when the emergency comes.

Fire controllers must be intent on methods and speed. Safety can help both if it is planned that way. Usually the safe job is the most efficient in the long run. Here are a few suggestions for fire-control planning.

1. Analyze accidents, then plan the job to prevent recurrences.
2. Make safety a part of every job. Until everybody is reasonably safety conscious, accident rates will remain high.
3. Plan ahead to prevent excessive overtime. Provide in advance for overhead and worker relief on fires, and for safe traveling to and from the job, especially at night.
4. Calculate human risks. Some areas might even be abandoned where the hazards are too great and the values too low.
5. Consider assigning a man full time to accident prevention and first aid on all large fires. The usual need for overhead on a fire may overshadow this, but is this not shortsighted? An injured man is at least a double liability on a fire. He is out of service and it usually takes one or two others to care for him. A safety man will help cut down on this loss.
6. Provide for safety in all equipment development and use. Are the tractors equipped with overhead guards for protection against falling snags or branches; are their tracks so guarded that there is no danger of foot injuries; and would a handrail or step make it safer to get on and off? Should the men have better eyeshields and smoke masks, or foot and leg guards for glancing axes? The field of personal protective equipment in the woods is almost unlimited, and not greatly developed.
7. Make brief safety check lists as aids to prevent accidents.

Third, *emphasize safety when recruiting.* Prior understanding with employing agencies and recruiting officers to select only those men who are physically fit and properly clothed for fire fighting will help eliminate accidents. This also applies to recruiting overhead from among permanent employees.

Many accidents come from failure to recognize potential danger. So consider mental outlook on safety when recruiting fire bosses, foremen, and straw bosses. Previous experience and training has much to do with this, which brings us to our fourth course of action.

Integrate safety in all job instruction. Safety key points need emphasis with fire overhead as well as fire line labor. Take advantage of all available minutes to stress safety, especially during their first hour on the job. They will never need help more, nor be more willing to accept it, than when they first start work. Train them to meet the job hazards.

What's the best way to do this? First, get your thoughts in order for a safe job when planning ahead. Then arouse the worker's interest. This should not be too difficult when one's life might be in the balance. Next tell, show, illustrate what you want him to do, one step at a time, always stressing safety. Then let him do it under close coaching. Finally, test him on the job. Follow up frequently. If the worker hasn't learned, the instructor hasn't taught.

Follow up—two very important words in job instruction and accident prevention. All too often they are forgotten. But if you want a top-notch safety job, don't forget to follow up.

Now let's summarize. To prevent accidents on the fire line we can—

1. Get active safety support from top management.
2. Include safety in all fire planning.
3. Emphasize safety when recruiting.
4. Integrate safety in all job instructions.

Finally, a word to work supervisors, don't forget to follow up!

Well's Tree-Marking Gun and Back-Firing Torch—Explosion Hazard Tests.—Explosion hazard tests have been completed by the National Bureau of Standards of the Well's tree-marking gun and back-firing torch, which was described in Fire Control Notes, October 1947, page 21. The Bureau's report is summed up as follows:

"The results of the tests showed that in the torch, as represented by the sample submitted, the likelihood of explosion inside the tank by ignition through the nozzle is remote. However, in the Bureau's opinion, a fine-mesh screen (preferably conical in shape and made of brass or bronze wire) should be inserted in the base of the nozzle to prevent particles of dirt or scale from clogging the discharge orifice. This screen would act as a flame arrestor. In the condition as received, it was not possible to obtain a satisfactory flame-throwing performance of the torch. The nozzle was taken apart and a particle of foreign material removed from the orifice in which it had lodged.

"In general, any device which uses a fuel of which one-half is gasoline is hazardous in the presence of flame as in this torch, even with safeguards. It is suggested that fine-mesh wire screen be inserted under the filler cap in the manner found in safety cans for gasoline to prevent an explosion if filling is done in the presence of fire. It would be desirable to instruct each operator as to possible hazards and give precautions as to its use."—DIVISION OF FIRE CONTROL, *Washington Office, U. S. Forest Service.*

THE HELICOPTER—BELL MODEL 47B

IRA C. FUNK, *Mechanical Engineer, Region 5, U. S. Forest Service*,
and FRED W. MILAM, *Operations Officer, L. A. Airways, Inc.*

This article is intended as a companion article to The Helicopter—A New Factor in Fire Control by Frank J. Jefferson appearing in the January 1948 issue of Fire Control Notes. It is based directly on Equipment and Development Report Number 12 of the Forest Service, United States Department of Agriculture.

All helicopter tests conducted to date by the Forest Service have shown that present-day helicopters have fairly definite limits of performance in mountainous country. That is, they can be depended upon to carry a full pay load to or from landing spots up to certain elevations. For landing spots above this elevation the loading must be reduced. Air temperature, wind, and other conditions at the landing spot greatly affect the amount of loading that can be safely carried.

Every one interested in the application of the helicopter to fire control and other work as well should become familiar with terminology used and the limits of operation of each make and model. Safety is a prerequisite in fire control as well as in other work and such a familiarity will aid in the prevention of accidents when using the helicopter.

DEFINITION OF TERMS USED IN HELICOPTER OPERATION

Pressure altitude is the altitude indicated by the aircraft altimeter when barometric corrector is set at 29.92 inches of mercury (N. A. C. A. standard barometric pressure at sea level).

Density altitude is the altitude under N. A. C. A. standard air conditions. True altitudes under field air conditions may be converted to the density altitudes having the same air density. Conversion of true altitude to density altitude is based on barometric pressure and air temperature. Conversion of pressure altitude to density altitude is based upon temperature only (table 1). In conversions, for the

TABLE 1.—*Density altitudes for different pressure altitudes*[1] *at various free air temperatures*

Pressure altitude (feet)	Density altitude when free air temperature is—							
	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.	90° F.	100° F.
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
0	-----	------	−700	0	600	1,200	1,900	2,500
1,000	−500	100	700	1,200	1,900	2,500	3,200	3,800
2,000	700	1,300	1,900	2,500	3,100	3,700	4,400	5,000
3,000	1,900	2,500	3,200	3,800	4,400	5,000	5,700	6,300
4,000	3,200	3,800	4,400	5,000	5,700	6,300	6,900	7,500
5,000	4,500	5,100	5,700	6,300	6,900	7,500	8,200	8,800
6,000	5,700	6,400	7,000	7,600	8,200	8,800	9,400	10,000
7,000	7,000	7,600	8,200	8,800	9,400	10,000	10,700	11,300
8,000	8,200	8,900	9,500	10,100	10,700	11,300	11,900	12,500
9,000	9,400	10,000	10,700	11,300	11,900	12,500	------	------

---

[1] For application in field, pressure altitude of landing spot may be assumed as equal to surveyed elevation for same.

same true altitude, summer temperatures have a greater effect than barometric pressures. Since all aircraft specifications are based upon N. A. C. A. standard air, all altitudes or ceilings given in such specifications are density altitudes.

True altitude is the measured or surveyed altitude or elevation above sea level.

Hovering with ground effect is the flight of a helicopter with zero air speed near enough to the ground or water surface to compress a cushion of high density air between the main rotor and the ground or water surface, thereby increasing the lift produced by the main rotor. Usually the main rotor must be within one-half of the rotor diameter of the ground to produce a ground cushion.

Hovering without ground effect is the flight of a helicopter with zero air speed at sufficient height above the ground or water surface to prevent the formation of an air cushion between the main rotor and the ground or water surface.

Translational lift is the lift supporting the helicopter due to the translational displacement of the craft through the air, that is, through air speed. When the helicopter is hovering or has zero air speed, under no wind condition, it has no translational lift.

Spot take-off is the take-off from hovering, usually with 2 to 3 feet ground clearance, from a landing area having a diameter about twice the greatest over-all dimension of the helicopter. The normal flight path of a helicopter on spot take-off is similar to that of a conventional airplane except the angle of climb is greater and no ground run is required.

Spot landing is the landing of a helicopter in a landing spot having a diameter of about twice the length of the helicopter.

Running take-off is the take-off of a helicopter running its wheels on the ground until sufficient air speed and translational lift are gained to permit taking off with maximum rate of climb. When operating at such high altitudes that the helicopter cannot hover, a running take-off may be necessary.

Running landing is a landing similar to that of conventional aircraft. When operating at such high altitudes that the helicopter cannot hover, it is necessary to maintain translational lift through air speed until after the wheels are on the ground.

Autorotation is the power-off operation of a helicopter in which the helicopter becomes an autogiro. By means of a free-wheeling unit the rotor is disengaged from the engine and lift is obtained through the windmilling of the blades. This is a standard maneuver which can be used for descent and emergency landings in all helicopters. Autorotation emergency landings are made in case of engine failure.

Revolutions per minute (*r. p. m.*), unless otherwise stated in this report, is engine speed in revolutions per minute.

Center of gravity (*c. g.*) is the longitudinal center of gravity of the helicopter with loading. The location of the center of gravity is the point at which the entire gross weight of the helicopter can be considered as being concentrated for the purpose of determining balance.

Gross weight is the total weight of the aircraft including pilot, passengers, cargo, fuel, oil, and any other loading carried by it.

Empty weight is the total weight of the aircraft with specified normal equipment but without residual fuel and oil, fuel and oil in tanks, pilot, parachutes, passengers, cargo, or special test equipment.

Useful load is the total weight of pilot, passengers or cargo, residual fuel and oil, and oil and fuel in tanks. This includes all loading not included in the empty weight.

Pay load is the total weight of passengers or cargo. It does not include fuel, oil, or pilot's weight.

Critical performance is the performance of a flight operation under conditions making the operation hazardous or impossible with normal power settings and flight procedure. Such flight operations can be safely accomplished if above normal engine revolutions per minute and experienced pilot technique are applied. Spot take-off and landings are classified as critical if more than normal engine revolutions per minute is necessary, or if hovering clearance, with normal engine revolutions per minute (3,000 revolutions per minute for Bell Model 47B) and full throttle, is less than 3 feet.

Easy performance is the performance of a flight operation under conditions that allow the operation to be accomplished with safety by experienced pilots with normal power settings and flight procedure.

TEST OPERATIONS OF THE BELL MODEL 47B

Tests were made to determine the pay-load capacities of the Bell Model 47B helicopters (figs. 1 and 2) in mountainous areas up to a maximum surveyed ground elevation at which the helicopter could make a spot landing and spot take-off with reasonable pay load, and with normal power. This included (1) determining the maximum gross weight for hovering, landing, and taking off from a small land-

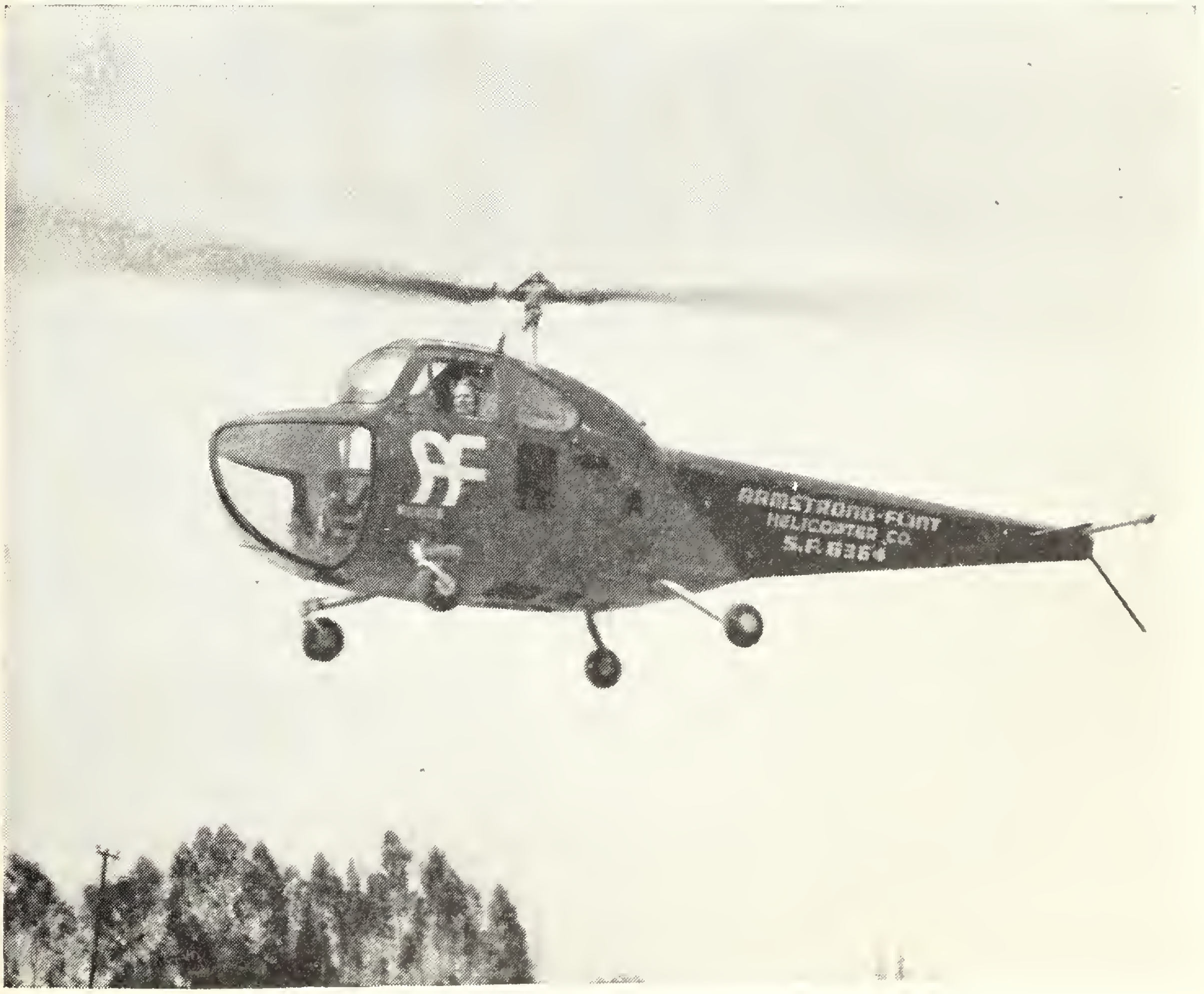


FIGURE 1.—Bell helicopter, model 47B, hovering.

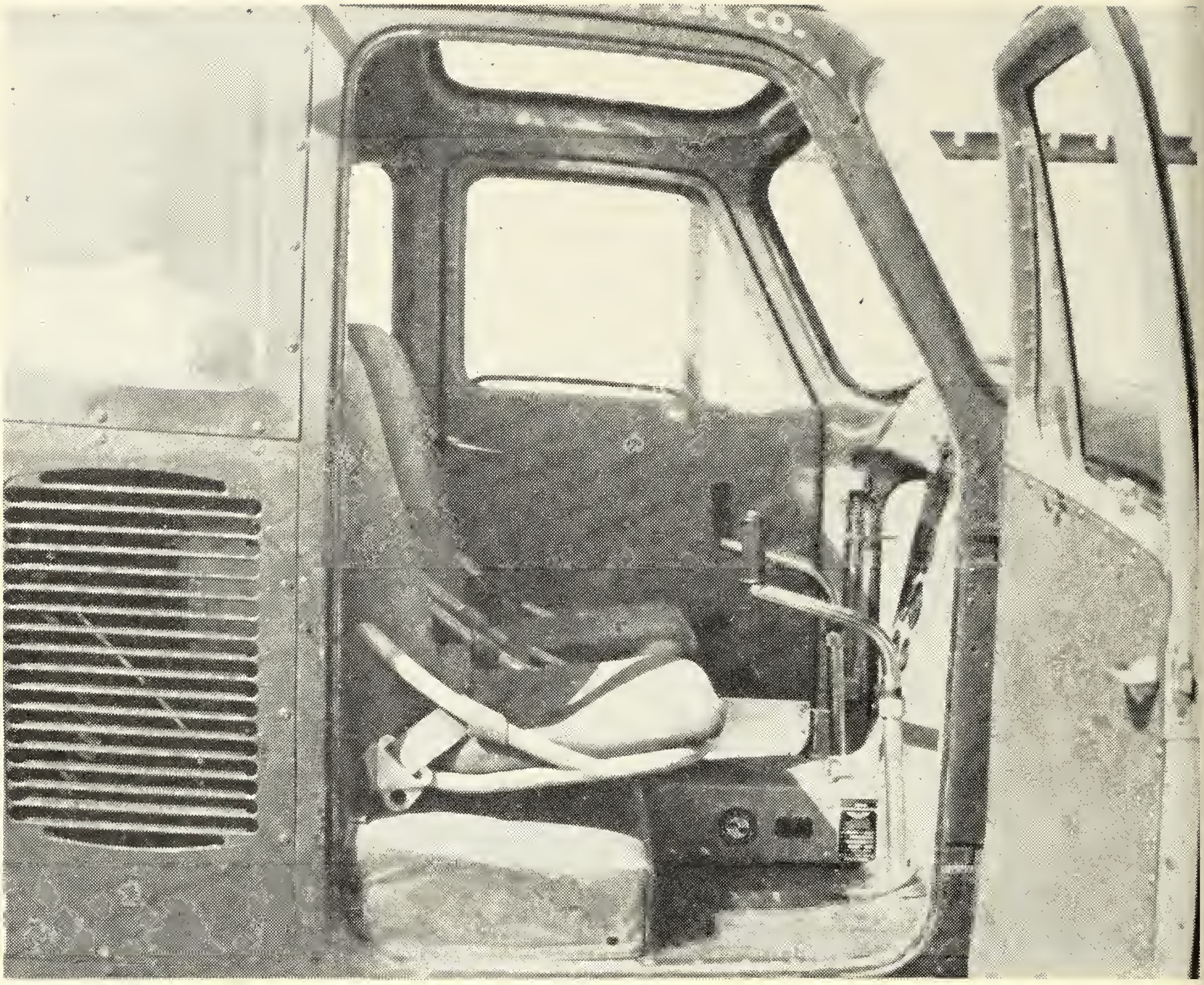


Figure 2.—Bell helicopter, model 47B, cabin arrangement.

ing spot with the wind velocity less than 5 miles per hour; and (2) checking tentative landing spots by flying a simulated landing approach (10 miles per hour above the indicated air speed necessary to maintain level flight at specified density altitudes) on the tentative landing spots.

This project is supplemental to the cooperative project conducted by the Air Rescue Service of the United States Army Air Force and the Forest Service, United States Department of Agriculture, with the Sikorsky (Army R5–A and R5–D) helicopters in 1946.[1] The flying of the Bell helicopter was performed under contract by the Armstrong-Flint Helicopter Co., Pacoima, Calif. The pilots of these tests were Knute Flint and Fred H. Bowen, both experienced helicopter pilots.

Normal procedure and power settings in tests for spot take-off were as follows: Helicopter was brought to a hovering position with from 1 to 3 feet ground clearance. Forward motion was maintained with this ground clearance until sufficient air speed (approximately 25 miles per hour, I. A. S.) was gained to establish translational lift. Usually 40 to 90 feet travel is necessary. Engine revolutions per minute may vary from 2,950 to 3,050, depending on density altitude, gustiness, and other atmospheric conditions, and how the ship feels to the pilot. After translational lift was gained, pitch was increased mainly to reduce the engine to 3,000 revolutions per minute (usually at full throttle), and at the same time to give necessary climb while indicated air speed was further increased to at least 45 miles per hour. The remainder of the climb was at 3,000 revolutions per minute and at full throttle.

---

[1] Funk, Ira C., and Knudsen, Carl S. HIGH LIGHTS FROM RESULTS OF HELICOPTER TESTS. Fire Control Notes 8 (1): 10–16, illus. 1947.

Normal procedure and power settings in tests for spot landings were as follows: Final approach was entered about 200 feet above the landing spot at 45 to 50 miles per hour with approximately 2,950 revolutions per minute. Descent was maintained so that on arrival at edge of landing spot clearance was 15 to 20 feet. Revolutions per minute was increased at this point to a maximum of 3,000 as air speed was reduced nearly to zero. At the same time, pitch was increased to check rate of descent. As soon as the ground cushion was established, pitch and power settings were reduced slightly to effect and maintain a hover. The helicopter was then let down to the ground by further reducing pitch and power settings.

Specifications of Bell Model 47B

Gross weight: 2,200 pounds.
Empty weight: 1,251 pounds.
Useful load: 679 pounds.
Allowable fore and aft displacement of c. g. (total inches): 4.88 inches.
Seating capacity:

  Pilot: 1
  Passenger: 1.

Fuel and oil capacity:

  Fuel: 33 gallons.
  Oil: 2 gallons.

Engine, Franklin, 6V4–178–B3: 178 horsepower.
Controls: Dual.
Dimensions:

  Over-all length (main rotor over tail rotor): 41 feet 2.5 inches.
  Over-all height: 8 feet 6 inches.
  Over-all width over stabilizer: 8 feet 6.7 inches.
  Main rotor diameter: 35 feet 1.5 inches.
  Tail rotor diameter: 5 feet 8.1 inches.
  Alighting gear width: 6 feet 6 inches.
  Cabin width inside: 4 feet 3 inches.
  Cabin height inside: 4 feet 4 inches.
  Tail rotor ground clearance: 3 feet 3 inches.

Performance with design gross weight

Maximum speed at sea level: 92 miles per hour.
Cruising speed at (75 percent b. hp.): 75 miles per hour.
Maximum rate of climb at sea level (45 miles per hour): 950 feet per minute.
Hovering ceiling without ground effect: 3,200 feet.
Service ceiling (rate of climb 100 feet per minute): 9,700 feet.
Fuel consumption cruising (approximately): 12 gallons per hour.

Maximum allowable gross weight for operations under various temperatures and elevations is given in table 2. Similarly pay-load values are given in table 3. Pay loads given in table 3 may be increased approximately 70 pounds when the wind at the landing spot is steady at 11 to 15 miles per hour and approximately 60 pounds when the landing spot is on a ridge top and thus permits flat approach and take-off and application of above normal engine and rotor revolutions per minute for a brief period.

TABLE 2.—*Maximum allowable gross weight for spot take-off and landing at specified pressure altitudes,*[1] *with wind velocity 0 to 5 miles per hour*

Pressure altitude (feet)	Gross weight when free air temperature is—							
	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.	90° F.	100° F.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
1,000	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,185
2,000	2,200	2,200	2,200	2,200	2,200	2,195	2,135	2,080
3,000	2,200	2,200	2,200	2,185	2,135	2,080	2,020	1,970
4,000	2,200	2,185	2,135	2,080	2,020	1,970	1,920	1,865
5,000	2,125	2,075	2,020	1,970	1,920	1,865	-----	-----
6,000	2,020	1,960	1,910	1,860	-----	-----	-----	-----
7,000	1,910	1,860	-----	-----	-----	-----	-----	-----
8,000	-----	-----	-----	-----	-----	-----	-----	-----

[1] For application in field, pressure altitude of landing spot may be assumed as equal to surveyed elevation for same.

TABLE 3.—*Maximum pay load*[1] *for spot take-off and landing at specified pressure altitudes*[2] *with wind velocity 0 to 5 miles per hour*

Pressure altitude (feet)	Maximum pay load when free air temperature is—							
	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.	90° F.	100° F.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	375	375	375	375	375	375	375	375
1,000	375	375	375	375	375	375	375	360
2,000	375	375	375	375	375	370	310	255
3,000	375	375	375	360	310	255	195	155
4,000	375	360	310	255	195	155	95	40
5,000	300	250	195	155	95	40	---	---
6,000	195	145	85	40	---	---	---	---
7,000	85	40	---	---	---	---	---	---
8,000	---	---	---	---	---	---	---	---

[1] Pay load allowing fuel for 100 miles range (16 gallons plus 4 gallons reserve), 170-pound pilot, and 2 gallons of oil.

[2] For application in field, pressure altitude of landing spot may be assumed as equal to surveyed elevation of same.

The pilot's weight is normally considered as 170 pounds. This was assumed in computing table 3. When the pilot's weight is 160 or 150 pounds, the pay load may be increased 10 or 20 pounds, respectively, over the amounts given in table 3.

Total fuel, including reserve, is 20 gallons (permitting operation for 80 minutes or 100 miles). By reducing fuel load to 16 gallons (60 minutes or 75 miles) the pay load may be increased 30 pounds. For a fuel load of 10 gallons (30 minutes or 38 miles) the pay load may be increased 60 pounds over the value given by the table.

Since conditions of landing spots affecting landing techniques vary so widely in mountainous areas, pilots must be highly experienced. Personnel directly supervising helicopter operations should have a thorough knowledge of helicopter flight characteristics and know how various factors affect their load limitations. The importance of this is illustrated by the following example.

On the Bryant Fire, Angeles National Forest, experienced pilots gradually increased loading and landing elevations until between 200- and 250-pound pay loads were carried to a ridge top landing spot having an elevation of 5,300 feet. Temperature was approximately 80° F. and wind velocity was steady at 11 to 13 miles per hour.

Application of the data given in this report indicates the maximum allowable pay load under the conditions on the Bryant Fire to be as follows:

	Pounds
Maximum pay load from table 3	40
Increase due to wind (11 to 13 miles per hour)	70
Increase due to ridge top landing spot and highly experienced pilots, and use of above normal revolutions per minute	60
Increase due to low pilot weight (150 pounds)	20
Increase due to low fuel (15 gallons)	36
Total pay load	226

Regardless of the helicopter's ability to lift a greater load, the gross weight of the Bell Model 47B should never be permitted to exceed 2,200 pounds, its licensed limit.

Landing spot requirements.—The Bell Model 47B is unusually stable in flight, and may be landed and taken off from a spot where small obstacles clear its over-all dimensions by only a few feet. Pilot fatigue is comparatively low for a helicopter.

Further study of the Bell helicopter's take-off flight characteristics is needed to determine definite landing spot requirements. Highly experienced pilots, with mountain operation experience, are capable of selecting landing spots that in most cases require little or no improvement before being used.

Experience to date, however, indicates that before any helicopter landing spots are chosen, the tentative spot should be checked *from the air by a helicopter* to determine if the approaches and take-off patterns are suitable. This cannot be done by a conventional type airplane since it is impossible to slow the airplane down to the speed that the helicopter would be flying on take-off and landing patterns. During the tests it was found that suitable landing spots could be located from the helicopter that appeared to be unsuitable when observed from conventional aircraft and from examination of aerial photographs and topography maps. Before a final decision is made to improve a landing spot, the spot must be checked on the ground to determine the amount of slope of the landing area. The Bell Model 47B does not have brakes on the landing gear, and so requires level ground where the helicopter is to stand.

There is little justification for expenditures in planning helicopter operations and preparing helicopter landing spots until helicopters are available for reconnaissance in connection with such planning work.

Maintenance.—At present there have not been sufficient Bell Model 47B helicopters in operation to give an accurate estimate of the required maintenance cost and depreciation. Under present CAA regulations it is necessary to magnaflux or zyglo inspect all parts of the rotor head and gear boxes every 100 hours. Undoubtedly, this will not be necessary as the flying time on the helicopter increases. At present it requires approximately 160 man-hours for a 100-hour inspection. This time will be reduced as experience is gained by the maintenance crew and certain precautionary measures are withdrawn by CAA. There are also a few mechanical problems that must be worked out before this helicopter could be depended upon to meet a rigid flying schedule day after day over a period of a month or longer.

The present contract cost is $50 to $70 per hour of flying time. The rate depends mainly on whether landings are to be made at unimproved spots, a factor which increases maintenance of the helicopter.

Suggested improvement of the Bell Model 47B helicopter.—The following improvements are needed on the Bell Model 47B in order to make it fully effective in all forest areas, especially where landing spots are between 4,000 and 9,000 feet, as in national forests located in Montana, Idaho, and the Pacific Northwest:

1. Increase hovering ceiling.
2. Increase service ceiling.
3. Raise tail rotor to clear higher obstacles.
4. Revise landing gear to increase clearance between fuselage and ground.
5. Provide parking brake.
6. Provide easy removal of controls from one seat.
7. Improve carburetor air filter for operating in extremely penetrating dust and ash conditions in burned over areas.
8. Provide cargo racks: in passenger's seat for such things as blankets, canteens, etc.; on floor for such things as small tools; on exterior of cabin for such things as long handled tools, shovels, and saws.
9. Provide hopper arrangements for dropping water in direct fire suppression.
10. Provide stretchers on side of helicopter for evacuating injured.

CONCLUSIONS

The tests made indicate that the Bell Model 47B helicopter, when flown by pilots that are highly experienced in operating helicopters in mountainous areas, is suitable for fire control operations up to an elevation of 6,000 feet where landing spot conditions are most favorable. In timbered areas with few bald ridge top spots for landing, its usefulness becomes limited. However, in the most diffcult situation, the Bell Model 47B can be depended upon to carry suitable pay loads to and from landing spots having elevations up to 3,200 feet and limited loads of strategic supplies to or from landing spots at higher elevations.

Plastic for Osborne Fire Finder Map Covers.—Another use was found for the versatile plastic on the Cleveland National Forest this season. A circular disk from $\frac{1}{16}$-inch Lucite, similar to Plexiglass, was used over the map on both Osborne and Bosworth fire finders to aid in preserving the maps and to hold the map in place. The disks should be cut approximately ⅛-inch smaller than the tin map disk to allow it to fit inside the disk screws and still be held in place by the heads of the screws. By use of the disks the task of gluing the map to the tin is eliminated, as a few strips of tape will hold the map to the tin and the weight of the plastic will hold the map flat. The advantage over glass is that the plastic won't break and is easily cut. But care must be used not to scratch the plastic. Most scratches can be removed with polishing rouge.

The same plastic material is also used for call card covers in radio equipped automotive equipment.—Stanley Stevenson, *Fire Control Officer, Cleveland National Forest.*

OBSERVATIONS ON FOUR PRESCRIBED FIRES IN THE COASTAL PLAIN OF VIRGINIA AND NORTH CAROLINA

Kenneth B. Pomeroy

Silviculturist, Southeastern Forest Experiment Station, U. S. Forest Service

The following article by Mr. Kenneth B. Pomeroy is a factual report of four prescribed burning experiments covering relatively small areas in the North Atlantic Coastal Plain designed to determine whether or not burning under controlled conditions would hasten reseeding of pine on areas where noncommercial hardwoods constituted the bulk of the stand prior to burning. The article is merely a factual report and is published here to make these facts of permanent record. It is not intended to carry a definite recommendation as to the widespread application of the principle of prescribed burning to secure seeding of loblolly pine in North Atlantic coastal areas where noncommercial hardwoods act as a deterrent to pine regeneration. The article is being published in Fire Control Notes because of the widespread interest in prescribed burning for silvicultural reasons.

Wide publicity has been given the use of fire as a silvicultural tool. Some foresters advocate prescribed burning for the improvement of seedbed conditions and as a means of reducing the competition from inferior species during the critical period of reproduction establishment. Other foresters contend that prescribed burning should not be encouraged while they are still trying to sell fire prevention to the public; that the sprouting ability of many hardwood species limits the duration of any reduction in crown competition; and that the release and preservation of existing seedlings will be the most economical means of stand regeneration.

Consequently, prescribed burning is a topic of considerable interest to foresters in the North Atlantic Coastal Plain. It was this trend toward more intensive forest management, concern over hardwood invasion, and unsatisfactory pine regeneration that prompted four organizations, three commercial and one Federal, to try prescribed burning during the fall of 1946.

THE TRACTS BURNED AND RESULTS OBTAINED

Tract 1

This 15-acre tract had been in a cut-over condition for 4 or 5 years. The seed source was ample, being 7 or 8 loblolly pine per acre, 16 to 20 inches d. b. h. Very few pine seedlings could be seen in the dense ground cover of young hardwoods, shrubs, and vines. Because of frequent summer and autumn showers, it was October 7 before weather conditions were judged to be right for burning. The intent was to burn as early in the fall as weather conditions would permit, because the seed trees were heavily laden with cones. Vegetation was in the transition stage. A 5-mile-per-hour wind was blowing from the north. Although no fire-danger station was being maintained in the vicinity, the fire danger was probably class 3.[1] The risks common to the use of fire were emphasized when all available manpower (eight men) had to be mustered to control a breakover along the fire line. The 6-inch furrow, prepared with a turning plow, was inadequate, partially because roots had caused the plow to skip. Seed trees 80 to 100 feet tall were damaged when the fire flared up higher than had been expected. Seven months later two of these trees were dead and four other had lost more than 75 percent of their needles.

Examination during the last week of the following May indicated a good burn was obtained on this tract. The aerial portions of 99 percent of the hardwoods were killed back to the ground. Nearly all of these trees were less than 4 inches d. b. h. Sprouts were visible on 55 percent of the stumps, with indications that more stumps would put forth sprouts (table 1).

TABLE 1.—*Stand table per acre for four tracts 7 months after burning*

Tree species and condition	Trees per acre on—			
	Tract 1	Tract 2	Tract 3	Tract 4
	Number	*Number*	*Number*	*Number*
Pine:				
Alive	100	130	88	0
Dead	425	22	100	0
Hardwood:				
Aerial portion alive	25	2, 554	75	25
Aerial portion dead:				
Sprouting	1, 700	2, 772	3, 100	2, 237
Not sprouting	1, 400	109	338	263

Company records indicate that during the first 3 months after burning, loblolly pine seeds fell on tract 1 at the rate of 205,000 per acre. Subsequent examination disclosed an average of 15,775 seedlings per acre in the cotyledon stage of development. Most of the tract was an open pine type that averaged 18,469 seedlings per acre. A stand of 6- to 10-inch d. b. h. oak trees on the remainder of the burned area did not drop their leaves until after the fire. These leaves covered nearly all of the surface. Only 5,000 seedlings per acre were present on this portion of the tract, although the distribution of seed trees was similar to that on the pine type. Stocking percentage for tract 1 was 100, as determined by percentage of milacre plots containing one or more seedlings.

---

[1] According to the Coastal Plain system of measurement rating fire danger on a scale of 1 to 5. It must be emphasized that fire danger class as rated in this paper is an estimate based upon on-the-ground observations by U. S. Forest Service personnel, who gaged such local factors as days since last rain, stage of vegetation, fuel moisture, and wind velocity. Such estimates are far from recommended procedure, but they were the best available.

Tract 2

The second tract to be burned had been logged under a strip clear-cutting method the previous spring. It was designed to burn this tract in early fall in order to take full advantage of the expected seed crop. Several abortive attempts at burning were made on days with a danger rating of 1 and 2. The job was not completed until October 25 when a wind of 8 to 12 miles per hour, combined with a fuel moisture content of 9 percent, indicated a class 3 fire day, which furnished the necessary impetus to spread the fire from one brush pile to another. The final burn on October 25, of approximately 30 acres, was accomplished by three men.

A clean burn was secured where the brush piles occurred. Most of the area between the piles was only lightly singed. In the burned area, hardwood stems up to 4 inches d. b. h. were killed. The average kill for the entire tract, including the unburned spots, was only 53 percent. Eight months later 96 percent of these trees had sprouted. The average for the tract is shown in table 1. A marked contrast was noted between the tract 2 kill on class 1–2 days and that on all tracts for class 3 days. On class 1 and 2 days almost no hardwood stems bigger than 1 inch in diameter were killed back. On a per acre basis only 27 of 152 pines 1 inch or less in diameter were killed by this light fire. However, on class 3 days more than 98 percent of the hardwood stems under 4 inches in diameter were killed back, as well as 92 percent of pine this size.

In large slash piles on tract 2, fuel up to 2 inches in diameter was consumed. The duff [2] was not completely consumed, even under the slash piles. The percentage consumed is shown in table 2.

Seed talley on this tract showed 127,440 per acre. A cutting test disclosed that 67 percent of the seeds were sound. A midsummer 1947 inspection indicated an average of 4,408 seedlings per acre. The seedlings with the best development and most vigorous appearance were found in the burned areas. Over twice as many seedlings germinated in the skid trails and jammer sets, but when germination occurred on bare soil, the seedlings were small and of poor color. The best germination occurred in skid trails having a ground cover of grass and weeds. Every milacre plot that fell in a skid trail or jammer set contained from 1 to 27 seedlings. No seedlings were found in 3 percent of the plots occurring on the burned area. In the unburned areas, 20 percent of the milacre plots did not have any seedlings. Number of seedlings by surface soil condition types is shown for tract 2 as follows:

Surface condition:	*Seedlings per acre*
Unburned	2,342
Burned	3,928
Skid trails and jammer sets	8,171
Average all conditions	4,408

The tract as a whole showed 93 percent stocking.

---

[2] The term "duff" is used here to denote all the natural accumulation of leaves and twigs above the surface of the soil.

Tract 3

This was a 30-acre forest-grown loblolly pine tract cut over in 1943 leaving 6 to 8 seed trees per acre. The ground on this 3-year-old slashing was covered with a dense growth of low shrubs, vines, and broom sedge, interspersed with hardwood sprouts 6 to 10 feet high. This area was burned on the same afternoon as tract 2. Wind velocity was 8 to 10 miles per hour, gusty; fuel moisture 9 percent; fire danger estimated as class 3. A well prepared fire line and good burning conditions enabled 16 men to burn this 30-acre tract in 3 hours.

Table 2.—*Duff consumed by fire on tract 2*

Kind of duff	Depth		Amount burned
	Before fire	After fire	
	Inches	*Inches*	*Percent*
Pine	2. 9	0. 8	72
Pine-hardwood	2. 5	. 5	80
Hardwood	2. 0	. 4	80

Here again, concentrations of brush in piles limited the effectiveness of the burn. Where the fire ran freely before the wind, an effective burn was obtained. In fact, the fire was so hot that a few residual pines 80 feet in height lost their crowns, although there was little or no slash near the base to cause damage to the tree trunks. Where fire was burning against the wind, it damaged only a few of the shrubs that occurred between the brush piles.

Subsequent tally indicated that 98 percent of the hardwoods were killed back to the ground. Sprouts occurred on 90 percent of these trees (table 1). Five percent of the seed trees lost a large portion of their needles but no dead trees were observed during the reexamination.

No estimate of the 1946 seed supply was made. It may have been relatively small because this was a diameter limit cutting leaving only 1 or 3 seed trees per acre. The 1947 inspection indicated 2,225 poorly distributed seedlings per acre and 68 percent stocking.

Tract 4

This 56-acre tract had been clear cut about 2 months before the burning took place preparatory to planting. All pine and hardwood trees over 4 inches d. b. h. were harvested. The interesting feature in this case was that the slash was scattered uniformly over the tract, a direct result of this company's method of logging. Eighty to ninety percent of the surface area was covered with slash to a depth of 3 to 6 feet. Seven men burned this tract in about 6 hours on an estimated class 3 day in early November.

Although the fire burned readily, the slash was not reduced to the extent desired, because of its green condition. Most of the twigs under one-half inch in diameter were consumed, but branches over 1 inch in diameter were not. The hardwoods were satisfactorily killed back to the ground. Only 1 percent produced new leaves in the crowns in 1947. Sprouting occurred on 89 percent of the fire-injured trees (table 1). The tract was planted in the spring of 1947 as no seed source remained after the clear cut.

CONCLUSIONS

More trials are needed to determine the value of prescribed burning as a silvicultural tool. The four attempts discussed in this paper are only mentioned in an effort to obtain a better understanding of the possible use of fire. Some of the conclusions, even though well known to fire control men, will bear repeating.

Good fire lines and careful planning are prerequisites to successful burning. The extra charges for fighting breakovers, having extra laborers present, and depending upon poorly constructed fire lines serve to emphasize this point.

For the season and region involved, conditions that combine to make a class 3 danger rating are required to develop a fire that will spread readily in cut-over slash area.

On days having a class 3 danger rating crowns of seed trees may be badly injured by flare-ups. It is important to move brush piles away from seed trees.

Burning on class 1 and 2 days killed the aerial portions of only one-half of the small hardwoods. On class 3 days over 98 percent of the hardwoods under 4 inches in diameter at breast height were killed back to the ground. Seedlings that germinate during the following growing season are thus given a better opportunity to become established.

Burning on class 3 days did not give a "clean" burn in the sense of consuming hardwood saplings, or slash, or duff to expose mineral soil. The fire consumed most of the limbs up to 2 inches in diameter in slash that had seasoned for 6 to 8 months. Branches over 1 inch in diameter did not burn readily in slash that was only 2 months old.

The total cost chargeable to prescribed burning was relatively high because of the safety and protective measures required.

A good initial catch of seedlings was secured when an ample supply of seed was available.

The reduction of hardwood competition will be of short duration because a large portion of the injured hardwoods sprouted during the first growing season following the fire.

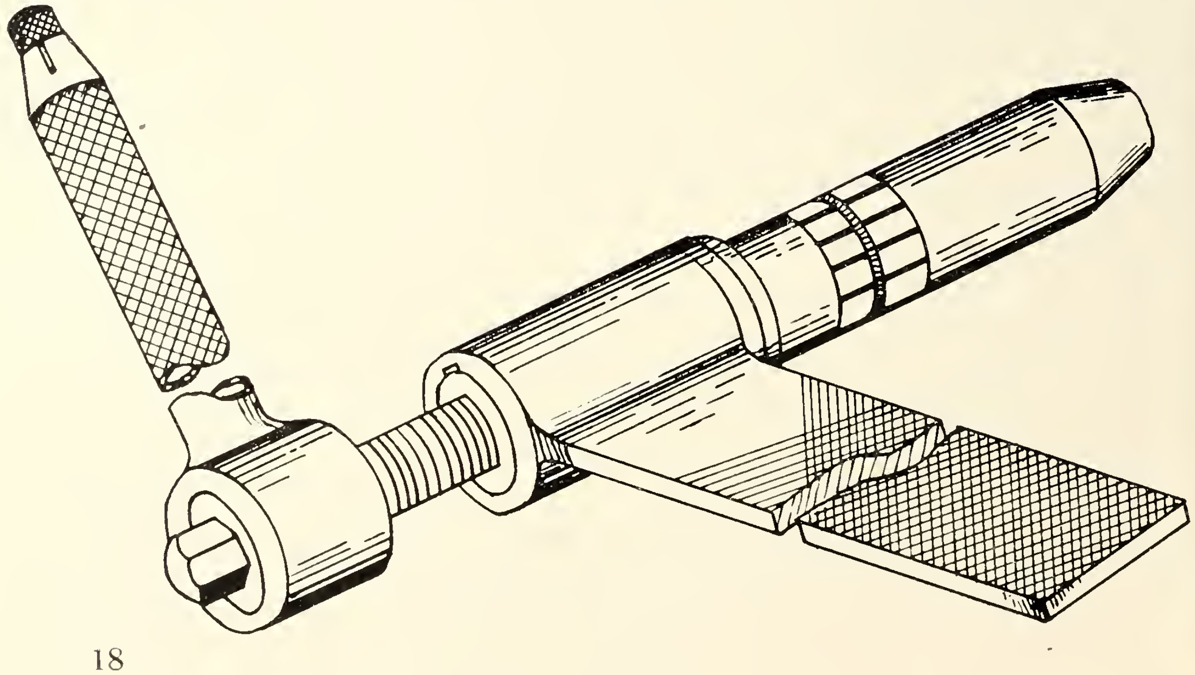
PORTABLE HOSE COUPLING EXPANDER

William M. Sherman

Superintendent, Forest Service Marine Station, Ketchikan, Alaska

A portable tool has been devised for replacing hose couplings in the field on Forest Service standard 1½-inch hose. The tool is a small compact unit stored in a case, 4 by 5 by 14 inches and easily assembled in a few seconds. It is a radial ferrule expanding device, so constructed that it can be held with the foot, similar to holding a pipe with a stilson wrench on the floor.

The coupling on the piece of hose to be discarded is removed by driving a chisel, or tool of similar nature, between the coupling and the expanded ring and prying the ring out. A ferrule is slipped over the segments of the expander. A slight shoulder about the thickness of the ferrule stops it from going beyond the segments. The hose is then inserted into the coupling, and shoved over the end of the expander until the coupling hits the stop, which sets the expander ring in the right spot. Stops are provided for both male and female couplings on the same head. If a rubber gasket is used, put it in ahead of the hose in the coupling. When the hose with the coupling and expander ring are on the device ready for the expansion of the ring, slip the foot vise over the key, put the arch of the foot over the round part of the foot vise with the toe over the knurled wing, slip the rachet on and expand the ring. When the ring is on, turn the rachet lock, run the rachet backward a stroke or two to relieve the expanding segments, remove rachet and unscrew with fingers until tool can be removed. The operation takes only a few minutes and saves delay in replacement of hose on a fire.



THE DISK-DOZER

H. M. White

Division of Fire Control, North Pacific Region, U. S. Forest Service

Equipment Development Report No. 9, December 17, 1946, described a clearing and trenching implement designed and constructed at the Portland, Oreg., Equipment Laboratory and Shop for attachment to the Beetle Tractor.[1] This implement was aptly named the disk-dozer by the late David P. Godwin. It showed such good possibilities for fire control line clearing and trenching that three similar disk-dozers were constructed at the Portland Shop for trial in other regions, and a larger one for trial in the North Pacific Region with the new Oliver HG tractor, for which orders had been placed by several regions. This tractor, with bulldozer, weighs 4,840 pounds. Because of delay in delivery of the tractors, the larger disk-dozer could not be tested until the fall of 1947.

As shown in figure 1, the disk-dozer consists of two rolling disks, mounted at right angles, and a combination cutting coulter, log pusher horn, small middle breaker, and wings to protect the disks, the whole assembly being mounted on channel steel for attachment to the A-frame of the tractor in place of the bulldozer blade and its arms. The change from bulldozer to disk-dozer can be made in a few minutes.

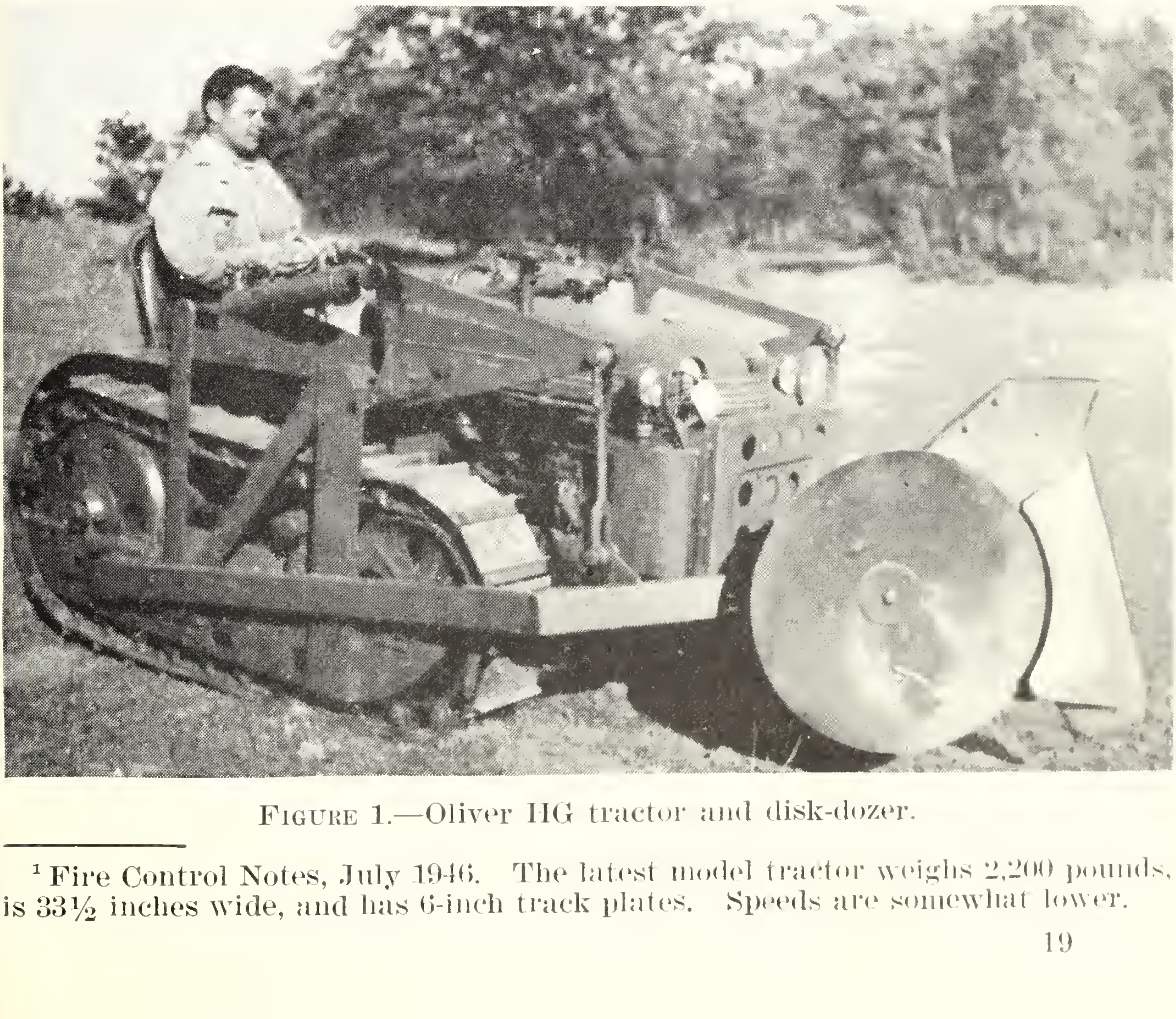


Figure 1.—Oliver HG tractor and disk-dozer.

---

[1] Fire Control Notes, July 1946. The latest model tractor weighs 2,200 pounds, is 33½ inches wide, and has 6-inch track plates. Speeds are somewhat lower.

The Beetle size unit has 22-inch disks and weighs 145 pounds. The larger size has 28-inch disks and weighs 390 pounds. The respective weights of the bulldozers on the two tractors are 125 and 345 pounds. It appears practicable and desirable to reduce the weight of the larger disk-dozer to less than that of the bulldozer blade which it replaces.

Tests so far made with the small disk-dozer in the North Pacific Region have indicated that, even without changes, it is better than a pull plow for use with the Beetle tractor. The first tests of the larger unit showed certain disadvantages, which it appeared might be overcome by further study and experimenting. It continuing the tests it was considered desirable to construct parallel lines with an Oliver tractor and disk-dozer and another tractor with bulldozer and Wescoatt plow.[2]

The preliminary tests were made on the east side of the Mount Hood National Forest in September, before the heavy fall rains. The soil, a heavy clay loam with considerable rock, was very dry in the open but somewhat moist under heavy cover. The tractor, with disk-dozer raised, was driven up a 50 percent south slope, having a cover of grass and weeds with occasional clumps of brush; then a trench was plowed down the slope. This operation was entirely satisfactory.

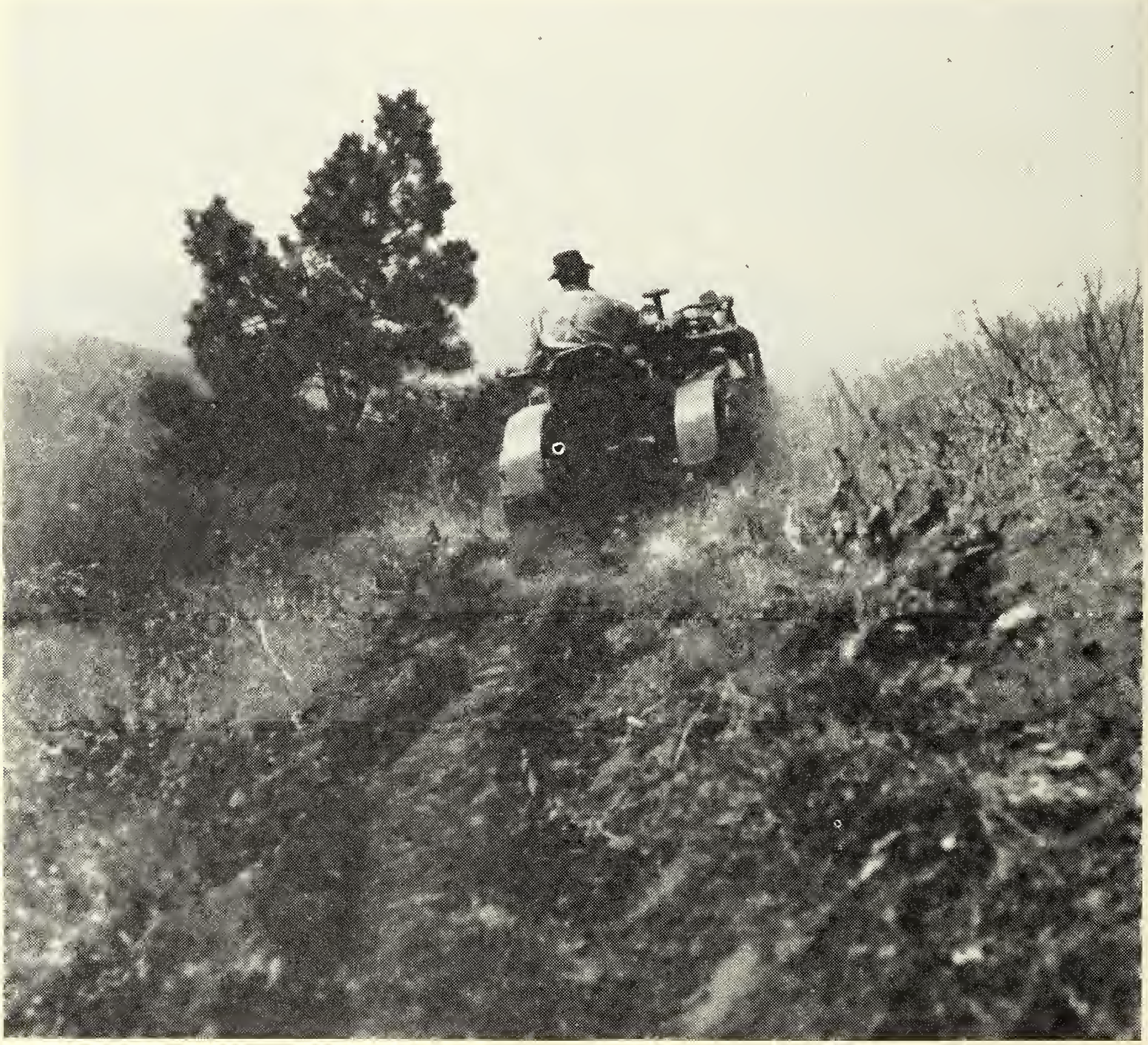


FIGURE 2.—One-disk trench along a 50-percent slope.

---

[2] E. D. Report No. 1.

One disk was then removed and a trench was plowed parallel with the slope (fig. 2). An excellent cupped trench was made, and the soil thrown on the downhill side lowered the grade under the tractor 4 percent.

On a north slope in ponderosa pine reproduction and brush, with quite a bit of down material and rock, the going was tough. The disks took considerable punishment without damage. Approximately 15 chains of line were constructed around an area at the rate of 38 chains per hour. The disk-dozer proved to be very effective for clearing away all kinds of ground cover, and it made an acceptable trench.

The comparative disk-dozer and plow tests were made in October on the Ochoco National Forest, on a north slope covered with a mixture of Douglas-fir, western larch, lodgepole pine, and ponderosa pine, and on more or less open ground in ponderosa pine. Reproduction was thick along more than half of the lines. The soil varied from clay loam to sandy loam, and from very rocky to little or no rock. While light rains had occurred, local men thought the implements would have made as good trench in this location at the height of the dry season, except that the roll would have been somewhat less.

Parallel lines about 20 feet apart were constructed with the two outfits, up over a hill then around and down to the point of beginning, a total distance of 96 chains. Except for one chain of 55 percent slope, where trenching was done straight down, slopes varied from 7 to 37 percent, uphill, and from 10 to 20 percent, downhill, with 31 chains approximately level and 3 chains along contour. Logs and debris were estimated as light for 57.5 chains, medium for 25.5 chains, and heavy for 13 chains.

Both outfits completed the lines in 2 hours, 5 minutes, or at the rate of 46 chains per hour. The disk-dozer went faster in thick cover and where there were logs, but the plow caught up in the open. The tractor with disk-dozer was in low gear (1.45 m. p. h.) all the way, while the other tractor was in second gear (2.30 m. p. h.) part of the time in the open.

As in the preliminary tests, the disk-dozer was especially effective for clearing away logs and other down material. The sharp coulter was much better than the bulldozer for breaking and moving logs, and hydraulic control of the implement facilitated the removal of heavy duff and rotten material. In backing, which had to be done frequently in heavy clearing, the advantage of having nothing behind the tractor was outstanding. It would, no doubt, have been more so if the tractor were equipped with a reversing clutch, as the Beetle and Clarkair are. The necessity for shifting gears reduces clearing speed with the disk-dozer relatively more than with the bulldozer and plow, because the plow interferes with backing even when a reversing clutch is used.

The bulldozer blade, used in angle position, had a tendency to "hang up" on logs and trees, and in backing the plow jack-knifed and at times interfered with turning movements of the tractor. Also, in heavy clearing where the full power of the tractor was needed for that operation, part of it was taken by the plow at times when that implement was doing no effective work but only digging deeper with every forward surge of the machine. This could be overcome to a large extent by controlling the plow hydraulically, but the lifted plow would still interfere with backing and would be a dead weight on the rear end of the tractor.

The disk-dozer went between small trees and laid them over to either side of the line, while the bulldozer laid most of them ahead. When the disk-dozer rode over the reproduction and brush, it was necessary to back up and get under them with the disks to root them out. The plow outfit had the advantage in this respect, because the disk-dozer operator, while thoroughly experienced with bulldozers, had never practiced with the disk-dozer.

Both outfits made good trench, the disk-dozer trench averaging about 7 feet, including roll, or about 40 percent wider than the plow trench on the level (fig. 3). Width of trench, under North Pacific Region conditions, might well be sacrificed to save power and gain speed. Neither implement appeared to have the advantage in rocky soil. The rocks did not materially damage the disks, which are standard farm disks and, therefore, replaceable at small cost.

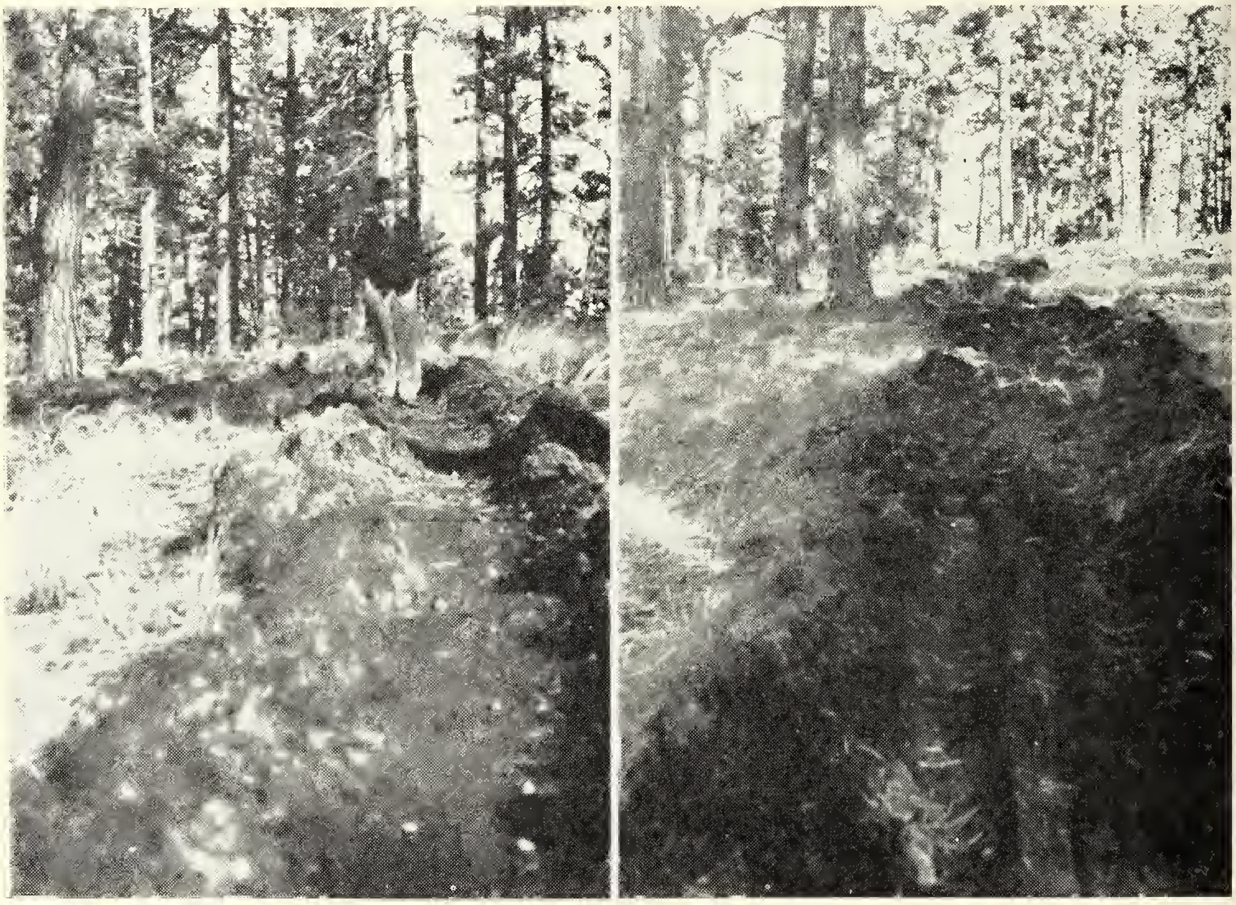


Figure 3.—Trenches made with Westcoatt plow (left) and disk-dozer (right).

One disk only was used on the steeper side slopes and for a short distance on level ground. The time for removal and replacement of the other disk was counted in the total time. Some practicable means of carrying the idle disk on the tractor will need to be devised. The one-disk trench was very good. On the level, in addition to less power consumption, there was the advantage of throwing no soil or debris to the "fire" side. However, the use of only one disk on the level is not practicable without some method of compensating for side thrust.

In all tests with the disk-dozer, the operator found it very difficult to control depth of trench. Working the hydraulic control almost constantly, even where there was no clearing to do, he could scarcely keep the implement at a constant depth, because it usually went in or came out too far before the action could be reversed. It seems likely that this disadvantage can be overcome by installing depth shoes on the disk-dozer frame back of and outside the disks. With effective depth shoes, the operator should be able to maintain uniform depth with down pressure on the implement.

The tractor with disk-dozer loads to better advantage than the tractor with plow. The former is backed into a standard 1½-ton truck, with the coulter just ahead of the endgate, giving excellent load distribution. The latter must be loaded with bulldozer forward and the plow overhanging, with the endgate removed, so that the weight is too far to the rear. However, both outfits were handled nicely in 1½-ton trucks, though there was an overload.

After considering the results of the tests, further development work on the disk-dozer for the Oliver HG tractor was recommended. Improvements found desirable would, of course, be incorporated in other sizes that might be constructed. The following development work is proposed:

1. Install depth shoes, quickly adjustable, to overcome wavy trench profile and to maintain uniform depth.
2. Try smaller disks, which will make narrower trench and thus save power and increase speed in light cover. Use new super-alloy disks.
3. Decrease depth of coulter and middle breaker to save power. Decrease thickness of this part of the implement. The pilot model is overly strong.
4. Experiment on level ground with one disk only and a long finned coulter as a means of overcoming side thrust.

Experience with the disk-dozer so far indicates that improvements to increase speed and make trench of uniform depth can be worked out and that, after this has been done, it will be much better than a bulldozer-plow combination for the clearing and trenching job under most conditions in the North Pacific Region. However, in areas with light cover and little or no rock, greater speed can probably be made with a drawn plow.

Suggestion to Facilitate Fire Sign Posting.—The suggestion in Fire Control Notes of October 1947, page 27, about how to fasten fire posters to backs brought out the following suggestion from a Region 4 forest supervisor.

Use four cupped brass washers, over-all diameter ¾-inch, with ¾-inch No. 6 brass round-head screws to fasten a 9- by 11-inch poster to the birdhouse back. Place bottom washers under poster at corners, and top washers at sides just below corners. Drill holes for screws.

The advantage of this system is that after the screws and washers are once in place all one has to do to replace signs is to loosen screws, remove old posters, insert new posters, and tighten screws. The only tool required is a small screw driver and there is no hammering or marring sign back. For the 14- by 22-inch birdhouse backs two additional washers are used at the middle of the sign.—DIVISION OF FIRE CONTROL, *Region 4, U. S. Forest Service.*

CONSOLIDATED FIRE ORGANIZATION CHART AND DISPATCHER'S BOARD

Fred G. Ames

District Ranger, De Soto National Forest, Mississippi

The combined fire organization chart and dispatching board in use on the Chickasawhay District of the Mississippi National Forests has been developed to a higher degree than is normally found. This district has had as many as 35 incendiary fires with one to scores of sets each within a 12-hour period and 254 fires in a 2-month period. Through use of the combination board and the dispatcher's individual fire record described below, the dispatcher has been able to keep abreast of each situation as it develops.

This consolidated board was developed to assist the dispatcher in keeping up with developments so that at a glance he can determine the organization and other facilities on the district available for fire duty.

The features of the consolidated board, as indicated by corresponding numbers on the diagram, are—

1. *Detection chart.*—Contains the name of each tower together with the name of the regular lookout, the name of the alternate lookout, and the tower manning schedule for that particular tower. In addition are the brief plans for emergency patrol and airplane use.

2. *Organization.*—The district organization is posted on index cards inverted and held in place by cupboard hooks to facilitate raising the cards to locate desired information. This portion of the dispatching board contains seven cards appropriately labeled: District Officers, Non-District Officers, Law Enforcement, Special Men, Food Supply, Other Supplies, and Special Equipment.

3. *Fire crew placement guide.*—A guide for the placement of all types of fire crews during the fire season, based on fire danger class ratings, lists the mechanized fire crew headquarters, the placement of Forest Service labor crews, and assignment of work projects that may be carried on along with the fire duty. The guide provides for week ends and holidays as well as work days, and also brief information on assignment of cooperator crews.

4. *Map of district (small scale).*—The dispatcher keeps locations of all crews available for call by use of numbered pins, the numbers corresponding with the crew numbers assigned as mentioned under 10, 11, and 12. (A red pin is used to denote a going fire and the individual crew pins are moved to the fire location as the crews are dispatched to that fire.)

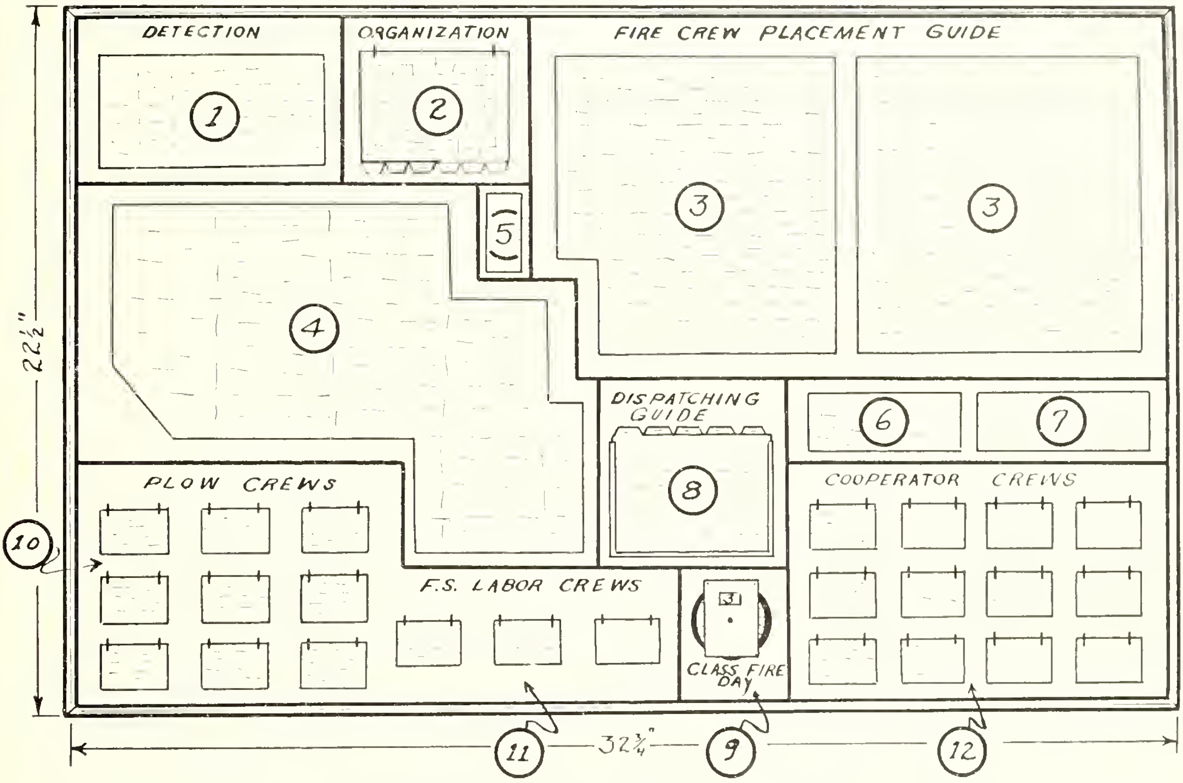
5. A small card consisting of a list of the elements necessary for a fire crew boss to know about a fire at the time he is dispatched to the fire—memory refresher for the dispatcher.

6. A small card listing conditions or occurrence of events which must be reported to the ranger by the dispatcher.

7. A small card listing conditions or occurrence of events which must be reported to the supervisor's office by the dispatcher.

8. *Dispatching guide.*—Provides information on the minimum manpower and equipment requirements for a going fire, based on the class of fire day. This information is posted on index cards appropriately labeled, one card for each class of fire day. The cards are held within slots so that the minimum dispatching requirements for the particular class of fire day can be placed in front for ready reference.

9. *Fire day class.*—A rotary chart on which the current fire day class is shown and which is the basis for organizational adjustments necessary for compliance with 3 and 8 above.



Chickasawhay Dispatching Board.

10. *Plow crews.*—Each plow crew is assigned a number and pertinent information concerning the plow crew is posted on small cards (1½ by 2 inches). The information posted on the cards is the crew number, crew base location, foreman, number of men, transportation facilities, tool cache, communication facilities, and food supply. The cards are hung on small cupboard hooks. As a crew drops out of the organization the card is turned back up.

11. *Forest Service labor crews.*—Posted and mounted similar to the cards for plow crews.

12. *Cooperator crews.*—Posted and mounted similar to the cards for plow crews.

An integral part of this concise, fast-moving fire organization plan is the Dispatcher's Individual Fire Record, which has been effectively used on the Chickasawhay District to reduce the time required by the dispatcher to record the events in connection with a fire. The form insures a more complete and concise record of events than would otherwise be possible, and with less effort on the part of the dispatcher. This is desirable on districts that often have several going fires at one time.

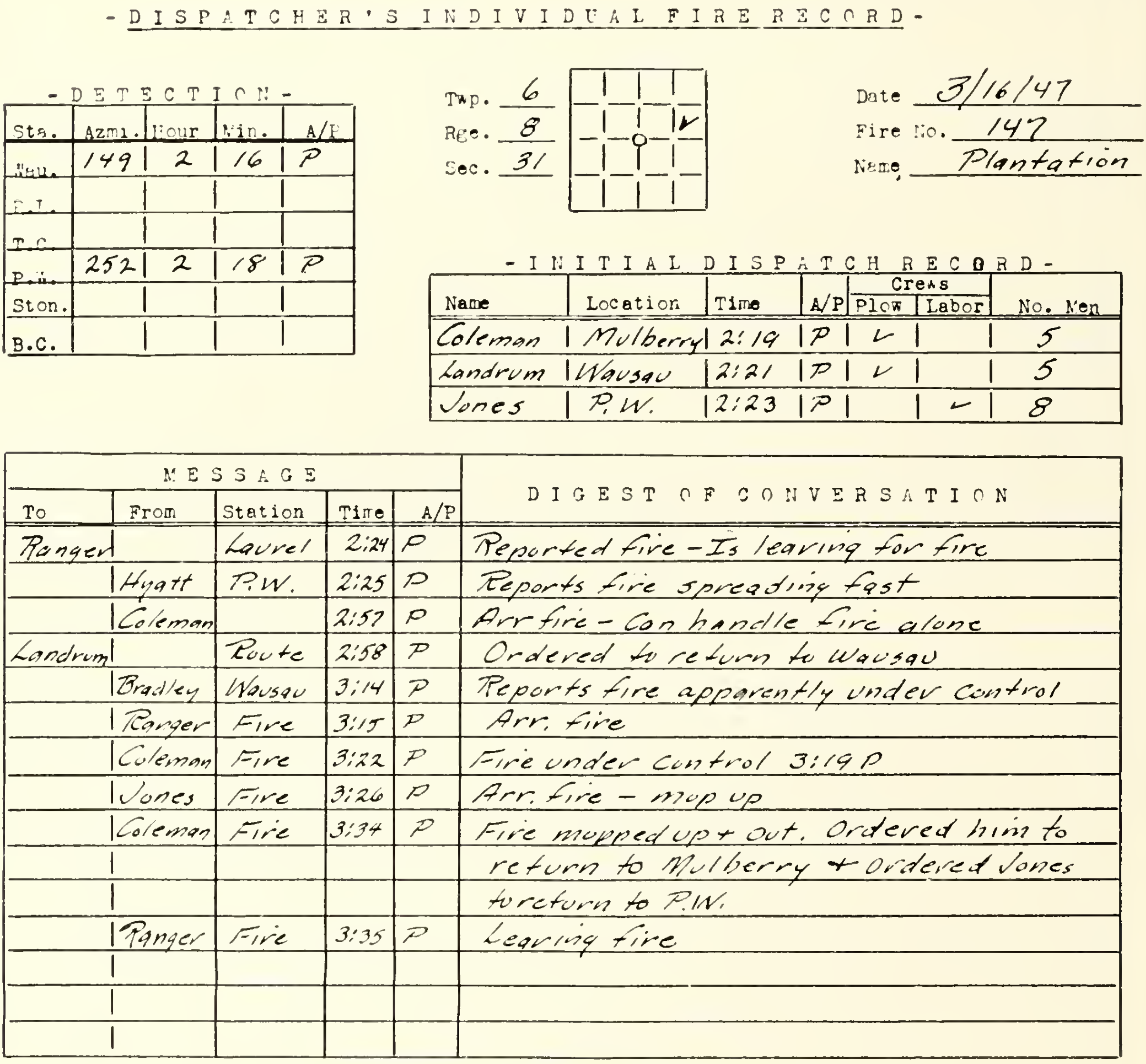
All information concerning detection, location of fire, and initial dispatch is recorded with relatively little writing.

This form greatly facilitates the review of action on fires. All information gathered by the dispatcher pertaining to one fire is recorded on a single letter size sheet. It is placed in a ring binder along with

This form greatly facilitates the review of action on fires. All in-

curring on which action is taken are recorded on the dispatcher's individual fire record, and all other types of events are recorded on the log and diary sheets. From time to time the sheets of both forms are removed, checked for chronological order, and bound for filing.

Another aid to the dispatcher is a set of aerial photographs indexed by townships and ranges with section lines marked thereon. These are conveniently filed by the dispatcher's desk so that at a glance he can tell what type and density of fuel and timber is involved and also can determine from this bird's-eye view if there are any roads or natural breaks which might not have been shown on the map.



-DISPATCHER'S INDIVIDUAL FIRE RECORD-

-DETECTION-

Sta.	Azmi.	Hour	Min.	A/P
Wau.	149	2	16	P
P.I.				
T.C.				
P.W.	252	2	18	P
Ston.				
B.C.				

Twp. 6
Rge. 8
Sec. 31

Date 3/16/47
Fire No. 147
Name Plantation

-INITIAL DISPATCH RECORD-

Name	Location	Time	A/P	Crews Plow	Crews Labor	No. Men
Coleman	Mulberry	2:19	P	✓		5
Landrum	Wausau	2:21	P	✓		5
Jones	P.W.	2:23	P		✓	8

MESSAGE To	From	Station	Time	A/P	DIGEST OF CONVERSATION
Ranger		Laurel	2:24	P	Reported fire - Is leaving for fire
	Hyatt	P.W.	2:25	P	Reports fire spreading fast
	Coleman		2:57	P	Arr fire - Can handle fire alone
Landrum		Route	2:58	P	Ordered to return to Wausau
	Bradley	Wausau	3:14	P	Reports fire apparently under control
	Ranger	Fire	3:15	P	Arr. fire
	Coleman	Fire	3:22	P	Fire under control 3:19 P
	Jones	Fire	3:26	P	Arr. fire - mop up
	Coleman	Fire	3:34	P	Fire mopped up + out. Ordered him to
					return to Mulberry + ordered Jones
					to return to P.W.
	Ranger	Fire	3:35	P	Leaving fire

Dispatcher's Individual Fire Record.

FIRE DAMAGE APPRAISAL

J. A. MITCHELL

Silviculturist, Lake States Forest Experiment Station, U. S. Forest Service

Fire damage appraisal is an involved and controversial subject. There is need, however, for a common policy in regard to damage appraisals for statistical purposes, if damage statistics are to be consistent and are to have historical and administrative value.

Unfortunately, forest fire damage is not an absolute quantity that can be precisely determined, since it involves certain more or less arbitrary assumptions and premises that must be established by agreement. Nor is any final settlement of the damage appraisal problem possible, since basic conditions as well as our conception of what constitutes damage are subject to change. The most that can be hoped for is agreement on a procedure that will serve current needs and give consistent and generally acceptable results. The last is important for, if damage estimates are not generally recognized as sound and reasonable, they carry little weight and tend to discredit fire control effort.

The legal basis for damages is the difference in value of the property involved before and after injury is sustained. Since the injured party is entitled to the continued undisturbed enjoyment of his property, however, his loss is not limited to the value of the part actually destroyed but to the depreciation in value of the property as a whole. Thus damage may properly include a reasonable valuation of any recognized benefits or values which may have been destroyed.

Forest fire damage, for example, may include not only the value of merchantable timber and young growth destroyed but also numerous direct, indirect, and intangible losses. The more important of these are:

- Forest damage:
  - Merchantable timber loss.
  - Young growth loss.
  - Damage to stand left.
- Other direct losses:
  - Grazing and wildlife values.
  - Productive capacity of the land.
  - Forest products.
  - Improvements.
- Other direct losses—Continued
  - Equipment, personal property, etc.
  - Suppression costs.
- Intangible losses:
  - Watershed values.
  - Economic values.
  - Social values.
  - Speculative and sentimental values.

Which of these items should be considered depends on the purpose for which the damage estimate is desired. A timberland owner, for example, suffers a direct financial loss represented by the tangible timber and property values destroyed, but is not directly concerned with such intangibles as watershed or social values. The public, on the other hand, suffers no direct property loss but is concerned with the loss of watershed, economic, and social values. Again, an individual who has acquired timberland for exploitation is concerned only with the merchantable values destroyed. But, if the property was bought as an investment, he may also suffer a loss of potential values. On the other hand, if the property is being managed for timber production, damage may be measured by the reduction in income or yield due to the fire. From the standpoint of statistics or fire control administration, both tangible and intangible losses may properly be considered.

The validity of all of the above items of loss is recognized. It is proposed, however, to confine the present discussion to ways and means of evaluating direct damage to merchantable timber and young growth. To further focus the discussion, it is also proposed to consider damage appraisal from the standpoint of fire statistics rather than that of compensation for damages. While the two might be the same, the latter calls for the specific loss in a particular case, whereas the former calls for an average figure generally applicable to similar stands.

There are three concepts on which damage can be based: (1) Market or sale value, (2) present worth or expectation value, and (3) cost or replacement values.

Depreciation in market or sale value is the most direct measure of tangible loss, and underlies all other methods of damage appraisal since, in the final analysis, marketability is the basis of value. Damage to merchantable timber is usually figured on this basis. It presumes, however, a demand for the property in question at a price fair to both buyer and seller.

Expectation value is the usual basis of appraisal in the case of inaccessible or immature timber for which there is no current demand. This calls for discounting the recognized future value of the property to its present value as an investment.

Cost or replacement values as a measure of damage have the advantage of being relatively simple to figure, but they are the least sound since they ignore the real value or intrinsic worth of the property. While sometimes used as a basis for compensation, neither cost nor replacement value can be justified as a measure of damage if they exceed the market or reasonable present worth of the property in question.

There is no question as to the applicability of market value as the basis of valuation in the case of mature timber. If, however, the timber involved is not mature, two questions of policy arise. First, should future increment be considered; second, should present or estimated future stumpage prices be used in computing loss?

The answers depend on whether the stand under consideration was to have been cut or was being held as an investment. If it would have been cut in the near future, current market value should be used. If, however, it was being held as an investment, a reasonable increase in volume and possibly quality might justifiably be considered. The use of anticipated future stumpage prices, however, is open to question, since the values resulting are purely speculative.

If the value of a stand at maturity is accepted as the basis of value for immature stands, the simplest way of determining present worth is to multiply the mean annual value increment by the age of the stand when destroyed. This amounts to simple interest on the bare land value at a rate which will give the predetermined maturity value in the specified number of years. This method, however, gives intermediate values higher than the actual market value at all points short of maturity.

A second method is to discount minimum merchantable value at compound interest to the age at which the stand is destroyed. The difficulty here is to determine the discount rate to be used. If the rate used is low, the initial and intermediate values derived may be too high. If high, the initial and intermediate values may be too low. From a strictly financial angle, the discount rate would be determined by the rate prevailing in the case of investments of equal desirability.

Another method is to use an agreed upon initial value. This automatically determines the discount rate but leaves the initial value to be used open to argument. It also results in varying discount rates, since the rate will change with any change in initial value, time interval, or maturity value.

As to the initial value that should be used, there are several schools of thought. One argues that it should be zero in all cases since we are dealing primarily with natural unmanaged stands, which have involved no outlay for establishment. Another argues that the average cost of planting should be used, since reproduction does not necessarily follow fire or may be slow in coming in. Others favor using planting cost where plantations are involved or artificial reforestation is likely to be necessary. The use of planting cost, however, assumes that the land is being held for timber production. It also introduces the third method of damage appraisal, i. e., cost or replacement values.

While cost and replacement values have much in common, they involve two distinctly different ideas. The proponents of cost value argue that the landowner is entitled to recapture his investment which may or may not include planting costs, but would include any actual expenditures plus interest.

Replacement value, on the other hand, ignores both actual cost and the real value of the property destroyed. The premise on which this method is based is that the cost of physical restoration is the proper measure of damage sustained. In this connection it might be pointed out that compensation for values lost, not physical replacement, is the legal basis of damage.

The policy laid down for the Forest Service by Greeley in 1925 called for determining damage on the basis of administrative and protection costs, plus compound interest at a rate determined by the expected maturity value of the stand at estimated future stumpage rates. Five dollars per acre was also added for planting where natural reproduction in a reasonable time was considered unlikely. This was all rather complicated to figure, but was reduced to tables based on site, type, and size class, for general use.

The present Lake States damage tables are based on the current average market value of 5- to 9-inch stands, discounted to the age when damaged at the rate of 5 percent. Theoretically at least, this represents the present value of immature stands as an investment. The method is simple and realistic, but admittedly conservative. Whether or not 5 percent is the proper discount rate to use may be open to argument. The real question at issue, however, is whether real worth or cost of production is the proper basis of loss.

It is conceivable that the day will come when the market value of timber will be determined by its cost of production. At present, however, the two have no relation. Since any excess of cost over realizable value is an investment loss that would be suffered whether the timber was destroyed or not, it hardly seems reasonable to charge this investment loss to fire. Looking at the matter realistically, therefore, the soundest basis for timber damage appraisal would appear to be the present worth of the timber as an investment.

A Helicopter in Fire Control.—After more than 25 years of fighting fire I feel that I have this summer witnessed a machine that is destined to play a more important role in fire suppression than any other one piece of fire equipment that we have at our command. This piece of equipment is the helicopter that was used on the Allen Ranch fire on the Eldorado and the Schuyler fire on the Mendocino.

I had the opportunity of riding in this machine on a reconnaissance flight and of observing some of its actions and performances under actual fire conditions.

On the Eldorado it was used as a scouting plane. From my own experience I actually saw more fire and fire-line conditions in 16 minutes of flight time than I could have seen by ground travel (foot and auto) in a full daylight day. I knew after this short flight just what I was up against as night fire boss. This information was not second hand when I got it; it was my own observation, and in addition I had a clear picture of the entire fire, roads, topography, and location of fire lines. To anyone going onto a fire in strange territory this is vital. Admittedly, maps and aerial photographs help a lot but to actually see the entire picture is the real pay-off. It places the fire boss in a position where he is much better prepared to analyze ground information that comes in from the lines and scouts.

On the Mendocino fire this same plane was used for scouting and transporting food to the lines. In one case the division boss (District Ranger St. John) scouted his division and then was set down almost in the middle of it. This saved him a lot of hard foot travel and, as he expressed it, a new pair of boots. Where St. John was set down was in one of the roughest parts of the fire.

To me the important features of the helicopter as applied to fire control are as follows:

1. It can fly low (treetop height) and slow. This gives the observer an ideal chance to see the ground conditions.
2. It can land most any place. On the Eldorado it landed on top of a lumber pile and in a small meadow. On the Mendocino it was landing on a wide spot in the road.
3. It can fly in and out of areas that would be impossible to get into with an airplane.

I feel that on a lightning forest like the Klamath a helicopter would pay its way in a very short time. Men could be put on, or near, small lightning fires within a few minutes of discovery. Now it takes 4 to 20 hours of hard travel on foot to get men in where the helicopter could do the job in a few minutes. On top of that fresh men would be on a small fire, not tired men on a much larger fire.

I feel that the time is not too far off when we will have centralized kitchens and the men on the line will be served hot meals, not the conventional nose bag.

By using a helicopter on patrol of larger fires many men could be eliminated. A helicopter, radio equipped, and in communication with a few men on the ground, could certainly direct a patrol job much better than we are doing now.

Many miles of fire roads and trails might be eliminated from our transportation system, thereby saving maintenance money that could be applied to better maintaining those roads and trails that we will have to have in our system.

Afer seeing this machine at work on two fires this year I am certainly sold on it, as are other northern men who have witnessed its work.—T. A. Bigelow, *Forest Engineer and Fire Control Officer, Klamath National Forest.*

MULTIPURPOSE TRACTOR-DRAWN TRAILER AND SLIP-ON PUMPER TANKER

R. A. MacIntyre[1] *and* George L. Bouck[2]

Region 5, U. S. Forest Service

Among the projects assigned in 1946 and 1947 to United States Forest Service Equipment Development Center, Arcadia, Calif., was the development of two tractor-drawn trailers. One was to be a lube and fuel service unit for tractors working on fire lines away from roads. The second was to be a tractor-drawn tanker trailer with pump. The first unit to be completed and field tested was a 1-ton capacity trailer with fuel and lube service equipment. This unit proved successful in "breakdown" tests, but when used on several large fires on Los Padres National Forest, the fuel capacity was found to be insufficient. As a result of this experience, field personnel recommended that the basic chassis design be retained, but the trailer be increased in size to accommodate six oil drums standing vertically and the fastenings or tie-downs be rearranged to suit general cargo hauling.

In view of these developments, it was decided that the lube and fuel service trailer and the tanker trailer be combined as a tractor-drawn utility trailer, as recommended, and that it be supplemented by a slip-on pumper-tanker unit to produce the tractor-drawn tanker trailer.

UTILITY TRAILER

The completed trailer has been constructed with a pay-load capacity of 1½ tons and the ability to travel fire line behind D–6 or larger tractor regardless of ruggedness of terrain or soil conditions. It also is capable of being drawn by vehicles other than tractors and can operate as a tractor fuel and lube unit transport, a slip-on pumper-tanker transport, or a utility supply trailer for any special purpose desired.

To meet the requirement of travel over rough terrain, the trailer body was constructed in the form of a stone boat (fig. 1, top). Sides are of 10- by 2⅝-inch channel iron. Front, bottom, and rear are of ¼-inch steel plate. The tongue, a 4 by 6 box beam, is of sufficient length to allow jackknifing of the trailer and tractor to 90 degrees. Principal dimensions are as follows: Over-all length 13 feet 2 inches, over-all width 7 feet 6½ inches, body length 7 feet 9½ inches, body width 4 feet 5¼ inches. Weight empty is 1,723 pounds. The trailer has Ford dual wheels with 8-ply 7.00 x 20 tires.

---

[1] Mechanical Engineer, Arcadia Fire Control Equipment Development Center.
[2] Area Superintendent, Equipment Service, Stockton Equipment Depot.

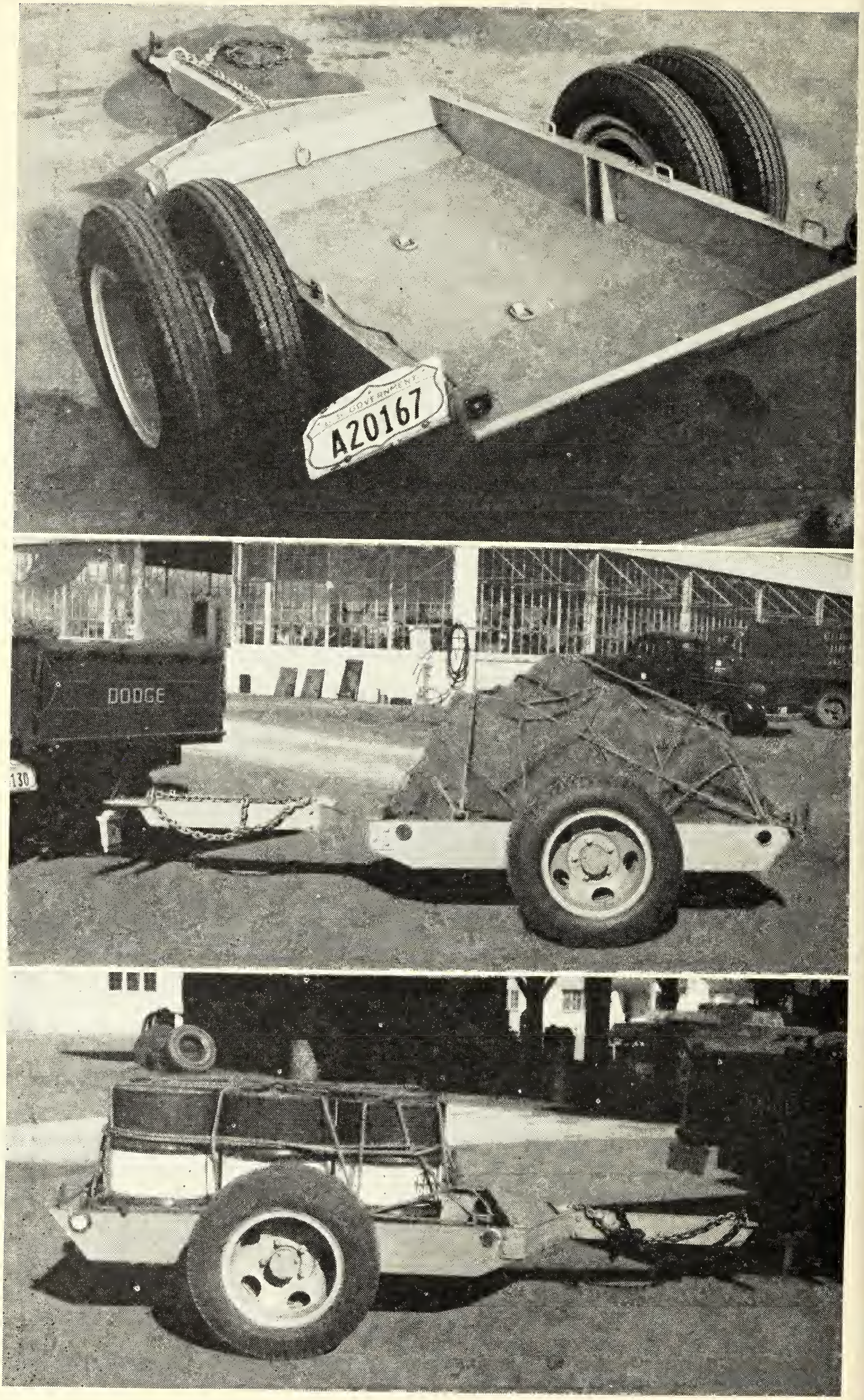


FIGURE 1.—Tractor-drawn utility trailer: Empty, with general cargo, and with load of fuel (barrels may also be carried on their sides).

Load tests and operation under actual fire line conditions at several large fires during the 1947 season have demonstrated that this trailer will follow wherever the pulling tractor can go. Hitched to a D–6, the trailer encountered no difficulty regardless of whether the wheels were mired and it was sledding along or whether it was being dragged over rocks, stumps, logs, or ditches with one or both wheels off the ground.

License plate and tail light bracket has been made detachable so that it can be removed when the trailer is operating in brush or under conditions where the bracket might be broken. The angle formed by reinforcements of the tongue has been boxed in and a hinged cover installed. This provides a storage space for tire tools, jack, lashing chains, rope, etc. Sufficient tie-downs are provided to allow for securing any type of cargo that might be put on the trailer (fig. 1).

Since the unit is primarily tractor drawn, no brakes have been installed. The tractor conforms, however, to all California State High way Vehicle Code requirements. For road work the unit has been towed behind a 1½-ton truck, but because it has no trailer brakes the use of a larger towing truck is recommended when the trailer is loaded.

Plans have been prepared, although construction has not been completed, for a slip-on convoy luber and fuel unit to fit this trailer. This luber will consist of a gas-engine-driven compressor and tank, two pressure lubrication pots, one drum of water, and four drums of fuel.

SLIP-ON PUMPER TANKER

A 400-gallon coffin-type tank is used for the skid-mounted slip-on pumper tanker (fig. 2). Tanks for such units are painted aluminum, since they are often used for hauling and storing drinking water, and it is desired that the water be kept as cool as possible if the tanks are exposed to direct rays of the sun. The hose basket on top of the tank will accommodate 1,000 feet of 1½-inch single cotton-jacket rubber-lined hose and 16 feet of 1½-inch suction hose. The tank suction pipe terminates at the suction manifold at the right center of the tank front. A 5-gallon pack-type gasoline tank is mounted to the left of the suction manifold and on top of the accessory box. The portable-type pumper unit mounts on a universal bracket to the left of the gasoline tank. Suction side of the pumper connects to the suction manifold through a short length of 1½-inch rubber hose. A relief valve is mounted on the discharge side of the pumper and its relief port discharge is returned through the ½-inch rubber hose to the tank "return" connection at top center of tank.

With the 1½-inch gate valve on the suction manifold closed and suction hose connected to manifold, water can be drafted from overboard direct to fire or to tank. With cap on the suction manifold and the 1½-inch gate valve open, water can be pumped from the tank to fire.

The back-pack gasoline tank is fitted with a ¼-inch shut-off cock near the bottom and is connected to the carburetor intake through a short length of airplane-type gasoline hose. This tank is mounted at sufficient height to insure gravity feed of fuel to the pumper unit.

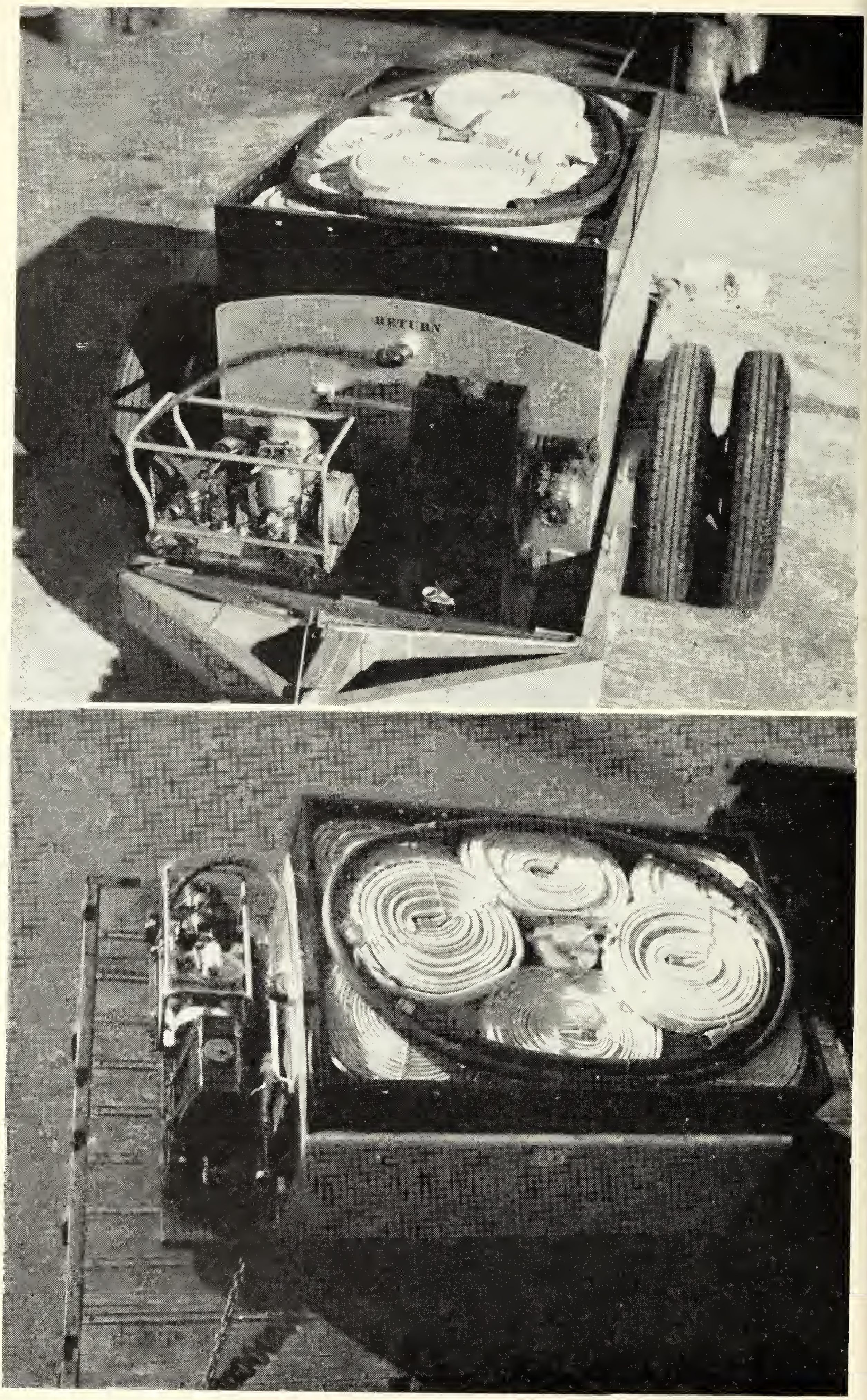


FIGURE 2.—Slip-on pumper tanker: Upper, mounted on a utility trailer; lower, mounted on 1½-ton stakeside truck.

The accessory box under the tank is used for the storage of repair tools, grease gun, nozzles, adapters, spanner wrench, etc., that are needed to make up a self-contained fire-fighting unit.

The bracket on which the pump is set has been designed for the quick mounting of the various portable pumpers in use by Region 5. This feature allows for the quick exchange of pumpers, if necessary, or for the removal of pumper for other uses while the tank is being used to haul water for other tankers.

Plans and detailed construction drawings are available and may be obtained for all of the above-described equipment from the Arcadia Fire Control Equipment Development Center, United States Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

Sound Economy on Fire Suppression.—During the past 35 years forest fire suppression has progressed from the day when a forest officer with a few men battled a large fire using a dry yucca stalk for a backfiring torch, often quite successfully, to the present day of fire fighting with the use of all modern equipment, bulldozers, flame throwers, radios, aircraft, rain-making devices, and, yes, 8-hour working days.

I can recall during the early years when we were brought to account and seriously criticized if suppression costs exceeded 50 cents per acre. Today the cost of fire suppression is staggering; it is true, of course, that labor, supplies, etc., all cost much more than 30 years ago.

The disturbing part is that with all the modern conveniences the output per man-hour, particularly where fire suppression requires hand labor, is pitifully small; also the fact that fires are still burning thousands of acres in spite of our many fire-fighting facilities. Numerous circulars, handbooks, and articles have been written covering all phases of fire suppression, job descriptions, individual instructions, organization, logistics, ad infinitum. Each of these seems to have produced more generals and less producers. Regardless of the purchasing power of the dollar, 60 minutes still make an hour. Don't we need to tighten our belts, produce more work and less manuals?

The old idea of 50 cents per acre for suppression was, of course, unsound. Nevertheless, the cost of fire control must be kept to a defensible and businesslike basis and consistent with the values protected. Neither must we be permitted to exaggerate the possibility as to where fires would spread if large expenditures had not been made.

Prompt and efficient initial attack may prevent a holocaust, but result in high cost for the area burned.

No one should question initial attack costs of fires within areas of high flammability, but when a fire escapes from a well organized initial attack force and is running wild is the time to do some careful planning for prompt control and mop-up after the lull which always follows, but no time to get excited and pour dollars into the caldron.

Let's take a realistic and cold-blooded analysis of suppression expenditures, particularly the output per man-hour, followed by an enforced policy of economy consistent with the actual values at stake.

Keep in mind FFF dollars are no different than the hard to get P and M and have to come out of the pockets of the taxpayer.—S. A. NASH-BOULDEN, *Forester, Region 5, U. S. Forest Service.*

THE COEUR D'ALENE AIR DETECTION PLAN

Ralph L. Hand

Forester, Division of Fire Control, Region 1, U. S. Forest Service

While the Coeur d'Alene Detection Plan evolved from the apparent success of aerial activity on the so-called Continental Area,[1] the two projects are actually as diverse as can well be imagined.

In order to appreciate the problems that confronted the planners in developing the Coeur d'Alene project, it seems desirable to briefly compare the two areas from the standpoint of their adaptability to aerial fire-control experimentation.

Continental Area.—Two and one-quarter million acres of roadless area; high, rugged, broken to some extent by barren, rocky ridge tops and open alpine meadows. Fuels in the timbered basins, mostly low to moderate hazard, with scattered pockets in the higher categories. Average fire occurrence, about 40 per season, 97 percent lightning-caused. Activity in the area confined to hunting, fishing, and other forms of recreation.

Coeur d'Alene Forest.—Slightly more than one million acres under protection, with an intensive road system. Area rough and broken, but continuously timbered with no breaks of consequence. Large continuous areas of medium to high fuels, with something over 100,000 acres of extreme artificial hazard in the nature of logging slash and smelter-fume kill. Average fire occurrence, about double that of the Continental Area or, on a per unit-of-area basis, four and one-half times as great, 30 percent being man-caused. Lumbering and mining activities extremely heavy, one or both being present over a large portion of the forest.

The Coeur d'Alene experiment differed from that of the Continental Area in that it was confined to the detection feature alone. Because of easy accessibility, suppression was handled entirely by small crews and station firemen, smoke jumping being considered impractical.

The experiment was conceived, developed, and carried out by the supervisor and his staff, with technical advice and assistance from the regional office. It is planned to continue during 1948.

PLANNING

Full advantage was taken of the knowledge gained in 1945 and 1946 in developing the combined ground and air detection scheme on the Continental Area. The first step was to make a 10-year study of fire occurrence on the Coeur d'Alene Forest, giving separate consideration to lightning and man-caused risk. A special hazard and risk-zone map was prepared and the process of re-sorting the lookout system was carried out in the usual way by reference to seen area maps. This sorting resulted in the retention of 8 fixed and 3 moving detectors out of a total of 33 that had been in use previously, and the direct coverage was thereby reduced from 69 percent to about 43 percent. However, by careful selection, it was possible to attain approximately 90 percent coverage in the high-hazard fuels and other important areas with the 11 positions in place.

---

[1] Hand, R. L., and Harris, H. K. preliminary report on aerial detection study. Fire Control Notes 8 (1): 28–32, illus.

It was decided that two light airplanes would be required to build up the coverage to an acceptable level under the worst probable conditions and that three observers would be necessary to provide for the proper amount of relief during periods of excessive flying. A contract was prepared which resulted in securing a Piper Super Cruiser and a Stinson Voyager, both equipped with radio on the proper frequency and the Voyager also equipped for night flying.

Techniques developed in the Continental Area were employed in perfecting general patrol routes, but it was found that much depended upon the ability of the observer and his ingenuity in seeking out and testing new methods. With the more intensive coverage confined to a smaller, compact area of high occurrence and with high-grade observers employed and used for that purpose alone, it was possible to make considerable progress. An indication of the increasing effectiveness of the air patrol is shown by the record of first discoveries.

From July 1 to August 2, the airplanes discovered only 2 out of 50 fires, or 4 percent. During the remainder of the season, which ended early in September, the air patrol is credited with 20 out of 89 fires, or 22 percent. This improvement is believed to be due not so much to increased flying, but rather to more effective flying.

The season of 1947 on the Coeur d'Alene was not bad from the standpoint of burning conditions, but well above average in intensity of the fire load. Several peak loads of 25 fires each were handled, apparently with no greater difficulty than under the old system, and a post-season analysis of discovery time for the past 10 years, shows an improvement in 1947, so far as average discovery time is concerned. Actually, when considering all groups from 15-minute discoveries to the long-time "hang-overs," there was no significant change, the 1947 record comparing favorably with the average of the 3 highest occurrence years in the past 10.

COSTS

In regular P&M funds there was a direct saving of $4,000 over what would have been spent under the old set-up. It is not quite so easy to make direct comparisons in the FFF cost item, but the total amount expended on the forest was $17,000 less than in 1946. The Coeur d'Alene was the only 1 among the 11 "fire forests" in Region 1 that did not find it necessary to spend FFF to place emergency lookouts despite a similar fire danger rating. Many Coeur d'Alene fires were scouted from the air, and false alarms were investigated, using P&M funds. None of the flying time was charged to FFF, although a good many hours were outside a lookout's regular tour of duty, and no week-end lookouts were financed from FFF. All of this served to hold down FFF charges without using any of the P&M savings.

CONCLUSIONS

We have yet a lot to learn about air detection and it would be presumptuous to make definite conclusions or predictions on the evidence of a single season's operation. However, the following statements, quoted from a preliminary report submitted by Assistant Supervisor Frank Blackmer of the Coeur d'Alene, reflect the concensus of those who watched closely or participated in the experiment:

1. We expected that it would not be easy to get cross shots on fires and that this would handicap smokechasing. Actually, this did not prove as serious as might be expected. This year with fewer lookouts we were able to train them better and they all became quite proficient in locating fires with only one shot. In addition, the plane was often used to help locate hard-to-find fires.
2. The planes cannot be in the air during a lightning storm. This is a handicap, but records show that in the past, only 26 percent of the lightning fires are discovered during the first 15 minutes. Because we had only "key" points manned in 1947, we still got 20 percent and the plane equipped for night flying was able to get into the air at night just as soon as the storm died down. The use of planes at night needs more study. We can find the fires but with present equipment, it is difficult to get an absolutely accurate "fix."
3. We knew finding hang-over fires from a plane would be difficult since they often puff up only intermittently. The record indicates that we did almost exactly as well finding hang-over fires as the 10-year lookout average and we think we can do better. One idea we want to try is a hang-over flight at dawn to try to pick up the smoke just as it starts to rise.
4. Results indicate that a qualified air observer can with practice give a very good fire location. He can also give additional information not available to a lookout that is of help to the smokechaser.
5. In general, communication was not completely satisfactory. All too often, there was a great deal of static and the observer had to spend time and energy "fighting" his radio which handicapped his detection effort. Very high frequency radio would probably be the answer. (Region 1 plans an FM net on the Coeur d'Alene as soon as possible.)

In conclusion, here are a few facts that seem to stand out clearly. First, in air detection we are dealing with something for which the future holds great promise. Ground detection techniques are well established with relatively little prospect of startling new developments. In air detection we have most of the "bugs" yet to work out. Second, the flexibility of air detection is particularly adaptable to the unstable and fluctuating pattern of the fire seasons, allowing opportunity for considerable savings if properly applied. Third, no direct comparison between air and ground detection is necessary or even possible at the present time; it is a matter of proper balance between the two services.

FIREFOG UNIT

A. B. Everts
Fire Staffman, Snoqualmie National Forest, U. S. Forest Service

Men who have had experience with grass fires know that it takes a relatively small amount of moisture to control or extinguish them. In the extensive cheatgrass areas of the West, fires frequently slow up or go out entirely in the late afternoon or early evening due to the moisture picked up from the air. However, fires in cheatgrass type are exceedingly fast spreading and it is not uncommon for them to burn 20,000 acres or more in an afternoon. And while the fuel is light, the momentum built up by such fires often sweeps them across plowed lines and even wide highways.

In South Dakota last fall, prairie fires swept over 380,000 acres of farm lands in 2 days, with losses in excess of 2 million dollars. Hastily plowed lines failed to stop the spread. It was necessary for fire crews to drop back to roads and backfire, and even this technique failed to work in many cases. Backfiring, under such conditions, is a science. It must be quickly and completely done; otherwise the backfire is apt to outflank the firing crew.

Since 1946 the Snoqualmie National Forest has been experimenting with a combination fire and fog unit attached to a tank truck, as a means of backfiring rapidly in grass types and holding the backfire with a fogged line. To date, four models have been constructed and three of them have been tested. The first two units were makeshift, but performed sufficiently well to justify further experimentation. In 1947, All-Service funds were allocated for this development, and the third model was constructed. At that time, we were still thinking of confining the idea to the control of grass fires.

This unit consisted of an angle iron A-frame, resting on a 10-inch rubber-tired caster and attached to the rear of a tank truck. A reversible fog-burner plate was carried in a slot in the center of the A-frame. On one side of this plate, liquid gas burners set the backfire, while on the other side, a single 1-inch low-pressure, low-velocity fog nozzle controlled the line.

In field tests conducted in September, we were able to fire and hold a line in cheatgrass at 8 miles per hour (fig. 1). Burning conditions were very unfavorable, with relative humidity 41 percent and wind 13 miles per hour. Previous short tests had shown that the better the burning conditions, the better the unit worked.

Further tests were made a week later on the Fremont National Forest in a sagebrush area which had been so heavily grazed that little grass remained. The line held on the windward side and to some extent on the flanks, but failed to hold on the lea side. It was reported that, because of the low position of the fog, the fire crossed the line through the tops of the sagebrush in some instances. Grazing men felt, however, that a unit of this kind might be used to handle fires in the lower sagebrush types.

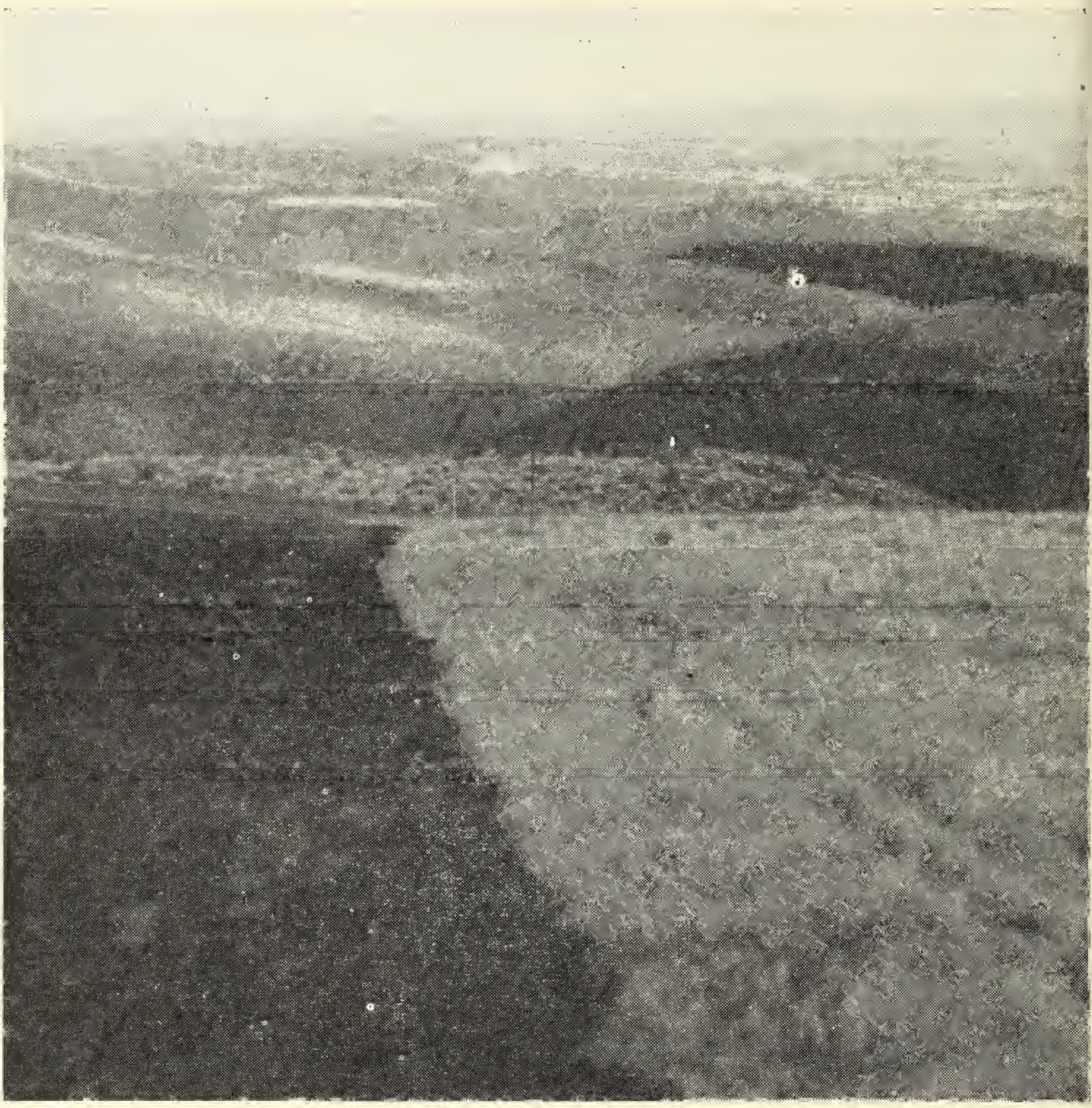


FIGURE 1.—Control line in cheatgrass type, constructed in the September 1947 test.

In these tests, it was obvious that many improvements in the design and construction of the unit could be made. It was, therefore, decided to assign the old unit to an east-side forest and to construct a new one for further experiments in 1948.

The new unit (fig. 2) incorporates the basic ideas of the earlier models, and, in addition, the idea of using Diesel oil in combination with liquid gas. The various parts are as follows.

The carrier arm consists of four 1-inch square pieces of steel tubing, 6 feet long and welded together. It is attached to the rear of a tank truck, at the outside edge, by means of a bracket. This bracket allows the arm to move up and down but not sideways. The arm is held in a horizontal position by a chain attached to the truck. The four steel tubes also serve another purpose: To carry, respectively, the water, gas, oil, and ignition lines.

The burner assembly consists of a plate, locked between the tubes, on which are mounted three liquid gas burners. Each burner can be independently locked, by means of a hand screw, at any desirable angle. Each burner has its own shut-off valve and its own spark plug for ignition. The middle burner is also provided with an oil jet, which has a number of adjustments from a long throw of 10 feet or more to a short, bushy, but terrifically hot flame. By properly adjusting the gas and oil, it is possible to leave a trail of burning oil on the fuel close to or several feet out from the fogged line.

The water bar is a 4-foot length of square tubing, the short end of which is counterbalanced with lead. This is to equalize thrust against the ball-bearing swivel coupling. The bar can be mounted either above or below the carrier arm, and also adjusted for angle. Three adjustable joints are spaced on the bar to receive the ¼-inch spray or fog tips of whatever design and water capacity is desired.

The control panel is an aluminum box containing the gas-control valve, oil-control valve, water shut-off, water strainer, and batteries, coils, and mechanism for lighting the burners. All control is in this panel. All fittings are of the quick-coupling type.

Gas and oil tanks are standard propane or "burner gas" tanks. One gas line runs through the control panel to the carrier arm. Another gas line runs to the oil tank. This line pressurizes the oil at about 100 pounds and forces it through the control panel to its tube on the carrier arm.

Fog and spray noozles of different types are on hand. These vary from free-floating fog to the driving type of jet noozles. Gallons-per-minute water consumption varies from 1.7 for the T-jet to 8 for the square spray.

Since this is still a test unit, all possible adjustments were provided so that tests could be made in different fuel types. Provisions have

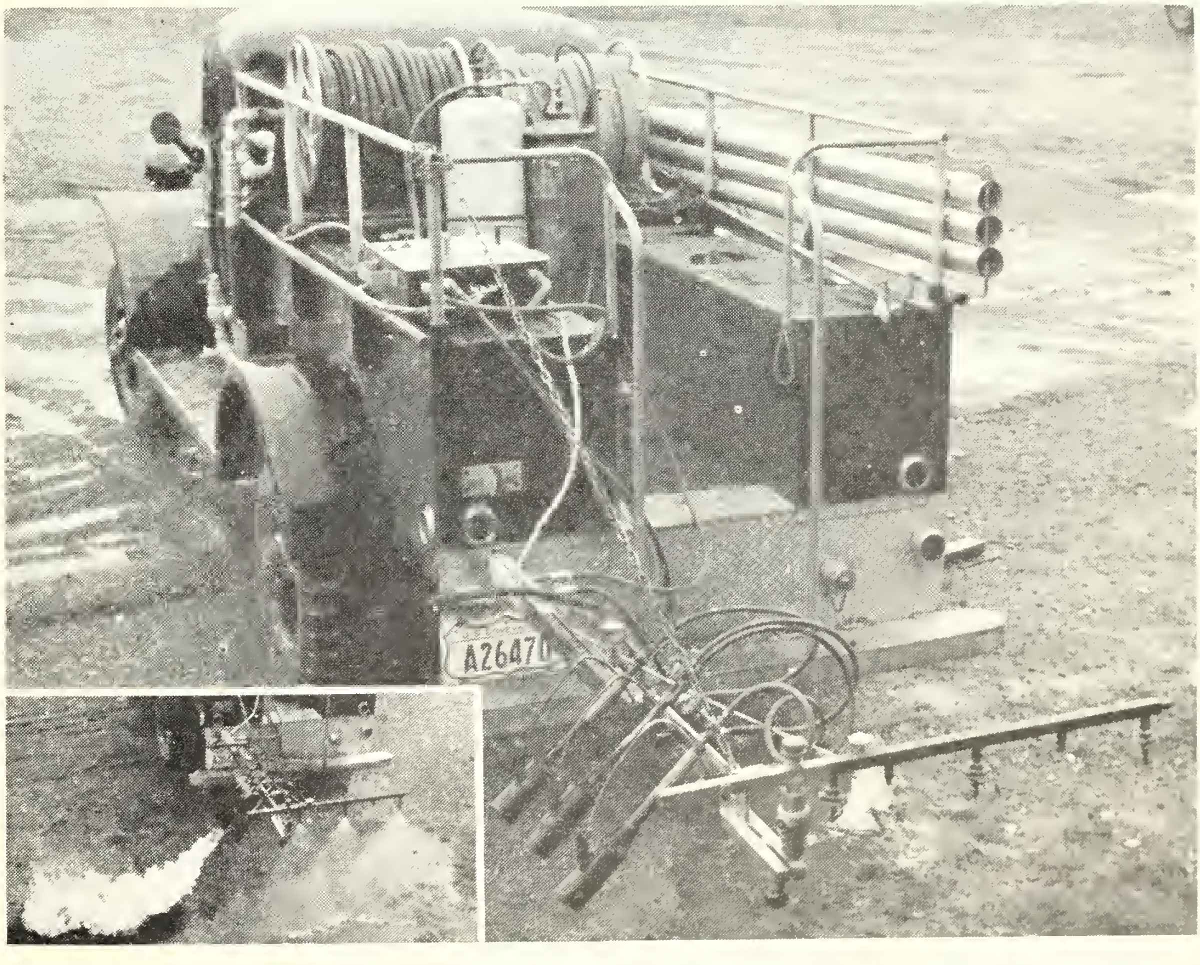


FIGURE 2.—The latest firefog unit mounted on a 1-ton 4 by 4 tank truck. Insert: Firefog unit with oil burner partly turned on and fog tips delivering 2.9 gallons per minute each at 150 pounds per square inch.

been made for using up to six spray tips if necessary. Width of fogged or sprayed line can be varied from 1 to 8 feet, water use from 2 to 22 gallons per minute.

It was found in the tests last fall that free-floating fog is dissipated considerably by the wind. The driving type of jets now on hand will overcome this difficulty. The addition of oil to the middle burner will easily handle the hard-to-ignite fuels. It was also found that the crushing effect of a dual-tired truck on the fuel was of some aid in constructing a line from which to backfire. For this reason, the carrier arm is mounted at the edge of the truck. An extra bracket is provided so that the arm can be moved to the other side of the truck, the burner assembly reversed, and firing done on that side. However, this may not always be necessary, as the burners can be adjusted so that they will shoot under the carrier arm and the water bar can be swung around to the opposite side in a minute.

It is obvious that the firefog unit will have the greatest operability if used on 4 by 4 tank trucks—possibly it can be used in areas with slopes up to 30 percent.

While intended primarily for fire suppression, the unit can also be used to burn out strips along roads, highways, and railroad rights-of-way as a fire-prevention measure.

Extensive field tests of the new unit are planned for next fall. This should furnish information as to just what an all-round unit should be, so that the design can be simplified as much as possible and a detailed specification can be written.

Report on a Wetting Agent: Drench.—We used "Drench" on the Dark River Fire (Mesaba No. 8) on October 19, 1947. The fire truck carried one ½-pint bottle of Drench for each back-pack pump. The chemical was poured into the 5 gallons of water in each pump can before packing the can to the fire.

Used with the spray nozzle, the first stroke pumped out a milky, frothy spray. The burning fuel was part swamp grass and part highland grass, dead—a hot fire. Each shot with the solution, however, immediately and completely put out a sizable spot of fire. It was fast and effective, and we are well pleased with the results of this trial on an actual fire.

We now carry ½-pint bottles with our pick-up units. The pumper pick-up has an additional ½-gallon jug of the solution ready to dump into the tank. We will report further on this commercial wetting agent as we have occasion to use it.—Louis Tauch, *District Ranger, Superior National Forest, Minn.*

MODIFYING THE ARMY INSECT SPRAYER (MODEL 3264) FOR USE AS SLIP-ON PUMPER TANKER ON ½-TON PICKUPS

Stanley R. Stevenson

Fire Control Staff Officer, Cleveland National Forest, California

To aid in meeting an increasing demand by field personnel for one- and two-man slip-on pumper units and temporarily replace pumpers worn out during the war years, the California Region of the United States Forest Service secured 83 Army insect sprayers (model 3264). They were purchased from the War Assets Administration in the spring of 1947 and used unaltered as slip-on pumpers on pickup trucks with reasonable success during the 1947 fire season.

The sprayer units consisted of a small, 2-cylinder plunger-type pump, powered by a V-belt drive from a 2-horsepower, 4-cycle, 1-cylinder, air-cooled engine. The pump and engine were mounted on a 50-gallon steel tank which, in turn, was mounted on wooden skids (fig. 1).

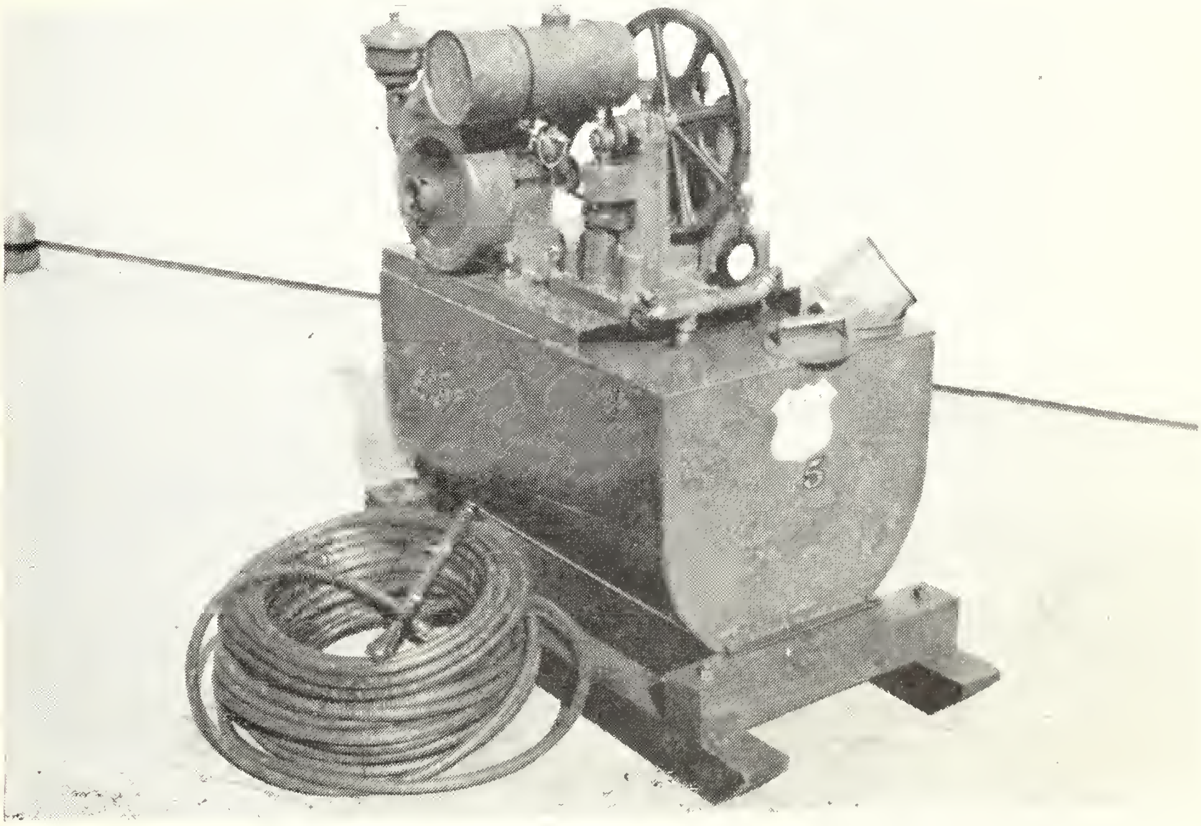


Figure 1.—Army insect sprayer (model 3264) before modification.

The units are capable of delivering 3 gallons per minute and operating up to 300 pounds per square inch discharge pressure. Accessories included 150 feet of ⅜-inch oil-proof rubber hose, spray nozzle, instruction books, and necessary spare parts.

As a result of field use during the 1947 fire season several improvements were suggested. A pilot model was constructed and standard alteration plans prepared by the United States Forest Service Fire Control Equipment Development Center at Arcadia, Calif. These plans incorporated field suggestions and utilized the original parts and materials as much as possible (fig. 2).

The following alterations and additions were made in the order listed:

1. Replaced skids with 4- by 4-inch timbers long enough to allow in-line mounting of tanks and engine-pump units.

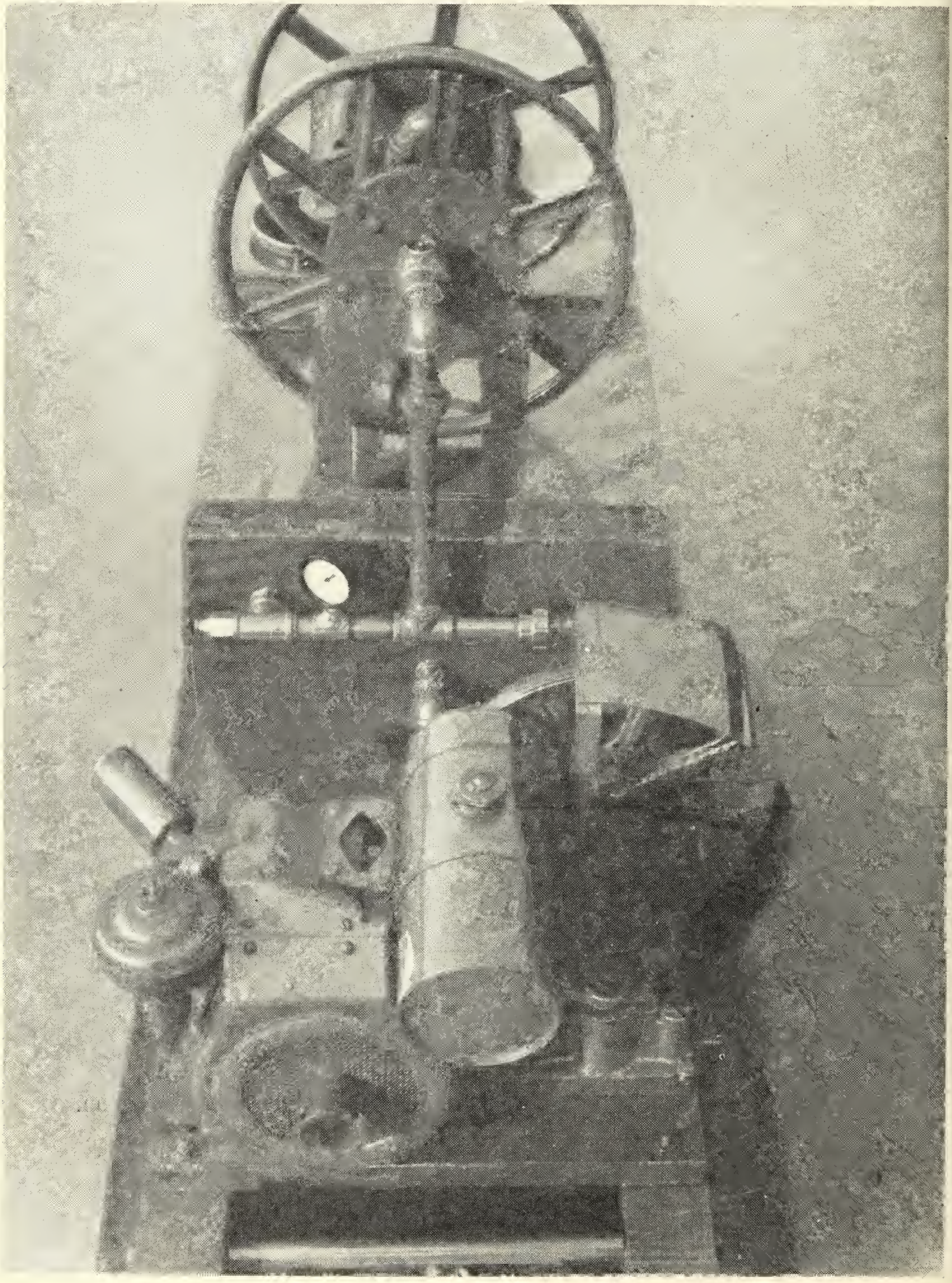


Figure 2.—Converted Army sprayer with engine and pump mounted in line and the live hose reel added.

2. Removed and discarded the agitator, shaft and suction strainer from the inside of the tank.
3. Installed new drain in the end of the tank.
4. Welded up all original holes in the tank, except the filler cap.
5. Welded new suction and return outlets into the end of the tank.
6. Added a clamp for fastening filler cap securely.
7. Attached a live reel capable of holding 200 feet of ⅜-inch high-pressure hose to the top of the tank.
8. Repiped the pump to the new tank outlets using as many of original fittings as possible.
9. Installed a safety guard over pump pulley.
10. Painted the entire unit except for the engine cooling fins.

The adaptations greatly improved the units by lowering the center of gravity, by making live reel operation possible, and by sealing several openings in the tank to prevent loss of water on rough roads.

The output of the pump was not affected by the alterations. Since the pumps were designed primarily for pumping Diesel oil and spray chemicals, they may not last more than 2 or 3 years in water-pumping service. However, since the cost of the entire unit was less than the normal price of the engine alone, suitable water pumps will be economically justified when and if it becomes necessary to replace the original pumps. Care in draining original pump after use and properly lubricating valves, piston, etc., will greatly aid in prolonging the life of the unit.

The adapted sprayer mounted on a pickup truck (fig. 3) is well suited for patrolmen or two-man crews covering light, flammable cover areas. One man can successfully handle the small ⅜-inch hose unaided and is assured of at least 15 minutes of continuous water application

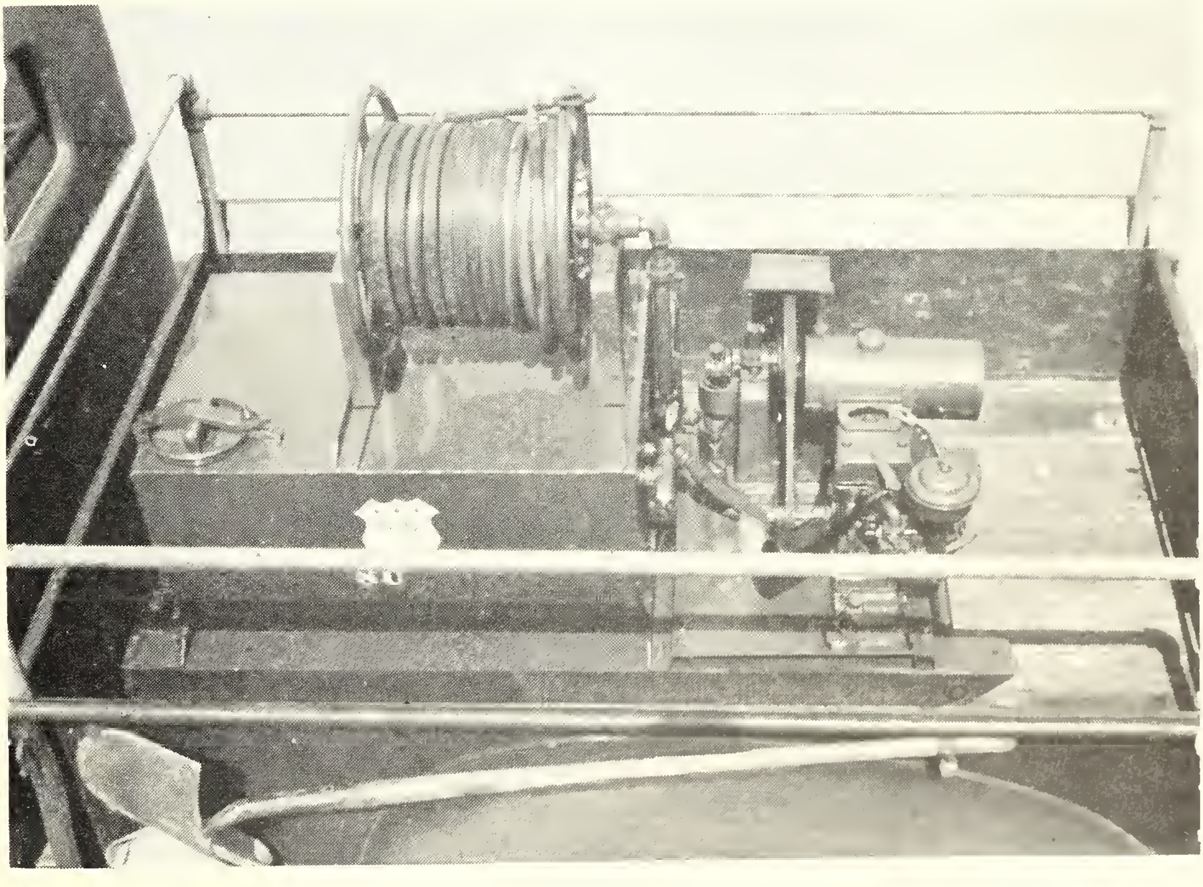


FIGURE 3.—Converted Army sprayer in a ½-ton pickup truck.

at maximum pressure and volume. The pumpers have been effective in suppressing fires in grass and light brush where fog and light sprays can be used successfully. The adjustable nozzle offers a limited selection of straight stream, spray, or fog application.

The Army sprayers were purchased new for $75 each. For each unit the conversion work, which is being done by local Forest Service equipment service branch shops, will cost approximately $55 for labor and $35 for parts and materials. The parts include $28 for the live reel. The total cost of each converted unit will be approximately $165.

Fire control agencies interested in the detailed drawings of the alterations can secure copies by writing to Arcadia Fire Control Equipment Development Center, 701 North Santa Anita Avenue, Arcadia, Calif.

Headlamp Modifications Required for Use of Metal Clad Batteries.—The use of metal clad flashlight batteries such as Ray-O-Vac has produced a material saving in our funds, because they have a much longer shelf life than the regular type battery.

Ray-O-Vac batteries will work satisfactorily in the new type 4-cell headlamps (F. S. Specification 178 Revised February 1947). Until the old 3-cell type flashlights are replaced by the new 4-cell type, a simple modification in them is necessary. The cup which contains the spare light globe in the base of the 3-cell battery case is too large in diameter to make a proper ground with the bottom of the Ray-O-Vac battery. This can be remedied in two ways. We recommend the second as the more satisfactory method.

1. A metal strip bent slightly convex is inserted at the base of the battery. This metal clip can be made of band iron 1⅜ inches long by ½ inch wide. This will give the necessary contact, but the metal strip is easily lost in changing batteries.

2. Remove metal cup containing spare light globe from base spring by cutting rivet with side-cutting pliers; remove spring from screw cap; place cup containing spare globe (globe side up) in screw cap; stretch spring about one-half inch and replace in screw cap over cup containing spare globe. Cup containing globe will rattle, unless soldered or riveted in place, but will not fall out unless spring is badly twisted out of shape. Soldering of cup in place is not recommended. Spring will now give satisfactory contact with all batteries, including Ray-O-Vac.—Ira C. Funk, *Mechanical Engineer, Equipment Development Center, Region 5, U. S. Forest Service.*

MISUSE OF THE FIRE DANGER METER

Arnold A. Buettner

Forest Ranger, Wisconsin Conservation Department, Antigo, Wis.

The Lake States Burning Index Meter, or "fire danger meter" as it is commonly called, is extensively used throughout the forest protection districts and probably is almost as much misused.

The meter, or burning index as it should rightfully be called, was prepared as a result of many experiments with every conceivable fuel type, temperature, air and fuel moisture condition, long and short periods of dryness, and large and small amounts of precipitation. As a result, it gives an accurate burning index on the factors mentioned.

Since the research work I have done on the precipitation and time factors produced nothing substantial to discredit the burning meter index, an explanation of the emphasis actually placed on these factors in its construction may clear up the skepticism of some of us toward it.

Numerous experiments showed that fuel moisture and air moisture, or absolute humidity, reach an equilibrium about 3 days after a rain. After that, the moisture in the air is the controlling factor for critical fuels. This fact was carefully incorporated in the burning index.

Some of us might not agree with this since the burning index places an increasing value on each day from the time of the last precipitation. This value is small with low hazard but increases daily with a larger rate with higher hazard. The reason for this is that "safe" is 0 to 1 percent while "extreme" is 50 to 100 percent. Therefore, an increase of 5 percent with "extreme" indicated conditions is, in reality, much smaller than 1 percent in "safe" or "very low" indicated conditions.

Most of us can remember the time when the duff hygrometer was considered to be the meter to measure hazard. It was found, however, that a dozen different readings could be obtained in the same number of tests made in close proximity. It, therefore, lost its popularity. Although the burning index or danger meter takes into account a number of factors, it can also be as unsatisfactory. This is particularly true during the shower months of July and August. A shower of considerable amount of precipitation and local in extent may occur at district headquarters and change the burning index to safe, while most of the district actually has a high burning index. In other words, it would be similar to sticking a duff hygrometer in a mud puddle; the reading would be as accurate. Of course, judgment enters into the picture and fire control measures are then based on judgment and the burning index is disregarded.

All these years we have been taking weather observations and computing the burning index for Weather Bureau purposes only, generally speaking. The burning index was correct for the headquarters and immediate vicinity but I doubt whether it gave the average burning index or fire danger for the district more than 30 percent of the time. It would be correct only during the spring (June) and fall (September) seasons of general rains of considerable amounts at which time an accurate reading would not be too important. It can, therefore, be concluded that the misuse of the burning index is the reason for unsatisfactory results rather than the meter itself.

Since air masses are homogeneous in character over a large area, it can be assumed that the moisture content of the air (absolute humidity) would be the same. It would, therefore, be possible to compute the burning index for a whole district, or the whole State in fact, from a single observation station. The observation would apply to the whole State as far as humidity, wind velocity, and, in most cases, stage of vegetation are concerned. Now if we took the average of the "amount of last rain" from the various rain gages throughout the district and the "days since rain" on the same basis, the burning index would be accurate over more area than the area covered by the district headquarters.

A good example of how erroneous the district headquarters burning index can be occurred in district four in August 1947. The last rain that was general fell on August 2, 1947, and ranged from 0.01 to 0.19 inch. On August 6, 1947, 0.07 inch occurred at Antigo, the district headquarters, and covered about 3 square miles in extent. On August 13, another 0.10 inch occurred at Antigo and lesser amounts at a few other points. A thorough check on this rain by rangers examining old fires in various parts of the district and by towermen reporting at towers, plus a careful check of cloud and shower movements, indicated that about 20 square miles of the 1,632 square miles of the district were covered. The district headquarters burning index, therefore, applied to less than 2 percent of the area. If the average were taken of the lowest precipitation that occurred at three of the five substations in the district, the burning index would have applied to 98 percent of the district and would also have indicated the worst possible burning conditions. The tower manning schedule and number of stand-bys per station would have been correct and personal judgment would not have entered into the picture.

This example illustrates the erroneous use of the headquarters burning index from August 2 until August 19, 1947, when the entire district received over a half inch of precipitation and the headquarters burning index again applied to the entire area.

We have been discussing burning index. However, before outlining my recommendations for computing fire danger, I would like to consider risk and fuel in relation to fire danger.

Risk, i. e., the causes of fires, in Wisconsin is 98 percent human element and 2 percent nature. We can break the human element down into the main responsibility classes: farmers or settlers, fishermen, berry pickers, and hunters. Each should have a positive value to be considered with the burning index. For example, in the spring shortly after the snow is gone, there are hundreds of farmers burning debris, a potential source of hundreds of forest fires. For the same burning index the danger is greater then than it would be with very few farmers burning. The factor could be determined by the number of burning permits issued, for example, 100 to 199, factor 1; 200 to 299, factor 2; etc. The dispatcher at the district office could determine the factor by the number of active permits on file. Fishermen could be treated similarly with the highest value or factor assigned to the opening day of trout season, the factor decreasing until the season's end. Berry pickers could be handled in the same manner as the various berries ripen. Similar factors could be given hunters during the hunting seasons.

However, it may be very difficult to place any values on fuel since they vary by districts, by type, arrangement, and amount.

The United States Forest Service, in its booklet Representative Fuel Types, has given us 38 fuel types arranged in 15 groups on the basis of rate of spread and resistance to control for spring and summer conditions, based on class 5 day. J. A. Mitchell, of the Lake States Forest Experiment Station, has recently completed a statement and tables dealing with rate of spread in fuel types with varying wind velocity and burning index. Consideration is also being given to reclassifying and reducing the number of fuel types. When this is completed, it will materially aid placing a danger factor on fuel.

At present throughout forest protection districts, an attempt is being made to prepare hazard maps from information gathered during inspections in the enforcement of the slash law. If a standard classification of fuel types were adopted, and used throughout all districts, a fuel factor could be determined for each district on the basis of percentages of the district under each fuel type and values placed on each type. The fuel factor could be also determined for subdistricts or even areas within visibility range of a tower.

Briefly, fire danger then would be based on all three factors necessary for starting a fire, namely, burning index; risk or human element, the spark or kindling agency; and fuels.

This method would strengthen the fire danger determining system by incorporating more factors. It would tend to eliminate chance since it weighs all factors, automatically increasing the hazard rating when a high fire starting potential exists and likewise reducing the hazard rating when there is very little burning being done and few people are in the woods. It will also increase the hazard rating in districts or areas with critical fuel types, and reduce it in others, definitely defining boundaries of areas on questionable days when part of the towers are to be manned and where ground crews can work.

Let us examine the method. For example we assume the burning index is 2 percent, which is a questionable point whether to man towers or not. There are over 300 active burning permits out, so let us say the risk factor is 3 percent. The district fuel factor we will say is 2 percent, making a total of 7 percent, indicating that the towers should be manned, and also indicating a stand-by of 2 men per station since fuel types are involved.

In another example the burning index is, let us say, 4 percent. There are very few farmers burning and no hunters, fishermen, or berry pickers, so the risk factor is zero. The time is late summer when fuel types are still green or dead fuels are mixed with green undergrowth. The fuel factor would be low, let us say 1 percent, making a total of 5 percent.

The second example has a higher burning index, but the other factors indicate a lower danger. Probably by using the three factors for determining danger, the maximum safe period could be placed at 6 percent. It would still mean that towers would be manned in the spring when the burning index factor is 2 or 3 percent but the other factors are high. Our present suppression system would be affected in that we would further strengthen our force when necessary and reduce to a greater extent when all factors indicate such a step to be safe.

Two recommendations are submitted for determining the burning index and fire danger.

1. Burning index for the district should be determined by using the lowest average district precipitation rather than headquarters reading. The precipitation totals from the substations and from any additional permanent gages where an accurate reading can be obtained daily should be classified in groups, 0.01 to 0.19, 0.20 to 0.49, 0.50 inch and up. Whatever group represents the largest part of the district should be used. For instance, four gages read 0.14, 0.24, 0.28, and 0.59 inch. Two readings fall in the 0.20- to 0.49-inch group, and, therefore, this group would be the one used in determining district burning index. The substation falling in the group lower than the one used would have to be considered separately. The present method should be used only for Weather Bureau reports, while the district burning index can be given on dispatcher's record and all forest protection reports. This will not increase the dispatcher's work load since the precipitation is called in daily from all substations. The weather pad is provided with extra columns in which district burning index can be recorded.

2. Fire danger should be calculated from the three factors, burning index, risk, and fuel, instead of from burning index alone. This should be done as soon as values can be placed on risk and fuel.

The risk factor can be determined by assigning positive values for farmers, based on the number of active burning permits; for hunters and fishermen, by seasons; for berry pickers, based on abundance of berries and when they ripen; and possibly for section crews during periods when they are doing right-of-way burning. The risk factor would then be the total of values for the responsibility classes applicable at the time plus a value for the class of day. The reason the class of day is taken into consideration is that the fire starting potential increases with an increase in the burning index.

The fuel factor may require considerable work. The fuel type classification needs to be standardized and hazard or fuel type maps completed for the district. When values are given fuel types, the fuel factor then would be fuel type value (based on rapidity of spread and resistance to control, at present for class 5 day) plus wind value (based on Beaufort or similar scale) plus class of day. If present fuel types were used, the class of day value would be a minus quantity for classes 1 through 4, a zero quantity for class 5, and a plus quantity for classes 6 and 7.

The recommendations and methods given are merely a different approach to rating fire danger. Some of the points outlined may have some value while others may be replaced by something much better. Nevertheless, if the material herein presented is of enough interest to arouse thought or discussion among the readers, something substantial in improved methods will surely follow, and the work already done by many will be incorporated in the results.

FOREST SMOKECHASER—A REGION 4 FIRE FILM

J. W. Mattsson

Forester, Fire Control, Region 4, U. S. Forest Service

Forest Smokechaser, Region 4's new 25-minute color fire film was released in November. This training film sets something of a record in fast and economical production. Field work began in September and took about 2½ weeks; cutting, final narration, and work print work were completed in October; processing at the Calvin Co. was done the first week of November. The over-all cost for producing this film, including processing, a master print, and contributed time is around $2,200. Prints are available to any interested region or other agency through the Chief's office and the Calvin Co., Kansas City, Mo.

This training film shows a forest smokechaser in action. The story stresses the work necessary to control a small hot fire and follows a smokechaser-lookout from the time of sighting a timber smoke until he finally suppresses the fire. The film is full of sound fundamental training practices in suppression tactics, including scouting, hotspotting, line building, and mop-up.

The actor, John W. Parker, Forester in the Division of Fire Control, Region 4, has been chasing smokes for 15 years. Parker, together with Director Horace E. Hedges, regional safety and training officer, and the writer who did the camera work, made up the production team. All three have had a good background of actual experience in fire suppression and with the knowledge gained from producing two other films in the preceding 2 years were in a pretty good position to turn out a worth while fire training film. The locale of the new film is the ponderosa pine belt in southern Idaho, country with fuel types typical of much of the western regions.

For those that have a desire to develop some training films but have hesitated because of high production costs and other problems, we want to take this opportunity in Fire Control Notes to point out some of the production problems and difficulties we encountered. We are highly optimistic in Region 4 that good films can be made without Hollywood budgets or professional actors, cameramen, or producers. It does, however, take a lot of enthusiasm and backing.

The following are points picked up in producing three films in Region 4 the last 3 years. No attempt has been made to go into technical production problems.

Administrative enthusiasm.—The basic requirement is to have the interest and enthusiasm of the Boss backed up by willingness to earmark dollars, time, and effort, with emphasis on the last two. Sure, delegation of authority is a necessity, but just as necessary is a central spark plug who will drive right down the course until the final cutting is done—someone who will follow through from the original idea and keep a close watch on developments right up to the final processing.

Adequate advance preparation.—This includes finding out what is wanted—reducing discussion generalities to specific practical production plans; getting departmental and interdivisional deadlocks out of the way before field work begins, and slugging a clear path for production. A fundamental prerequisite is the formulation of a story or a theme, some human interest central theme that preaches what you are trying to get across. This forms the basis for the rough shooting and narrative script. This working script should tell the story in logical sequence, and if it does you are bound to tell the same story in pictures.

Equipment, films, and facilities.—The minimum equipment required for an outdoor film is as follows:

Professional 16-mm. camera.
Dependable light meter.
Sturdy tripod and T.
One-inch lens.
Two-inch lens.
Wide angle lens.
Small slate and chalk or number board.
Reflectors (exterior), homemade tinfoil frames, costing about $2.

If some inside shooting is planned, you would have to add floodlights, cable, and spots to the list. We have found it pays to hold inside shooting to a minimum; it is costly and time consuming, especially if any animation or complicated graphs or charts are included.

Plan to buy enough film at one time so the emulsion number is the same. This will aid in getting uniformity in color. You will need about three times as much film as you contemplate for the length of the finished picture, that is, a 1,000-foot film would generally require that you expose between 2,500 and 3,000 feet of film. A standard practice of 16-mm. professional producers is to shoot each scene twice; the first exposure set from a normal meter reading and the other at ½ stop light, opening up and getting a lighter scene.

One thing we learned the hard way—be sure and shoot each scene plenty long—and get extra footage on each end even though you later cut a lot of it out. You never know when this extra footage will be needed for titles, flashes, to catch all action, or to fit in with desired narration.

Practice action.—The best hours for photography are from about 10 a. m. to 4 p. m., but avoid high noon. At this time the lack of shadows seems to give a flat effect and the exposure is unnatural, especially for close-ups of people. This does not mean your working hours are limited to between 10 a. m. and 4 p. m. Before and after these hours you can get in your best licks practicing and going over actions, getting ready to shoot, and working out the next day's shooting schedules.

Tell your story in the photography.—Make your pictures carry the story, don't depend on the narration to do it. When shooting single action scenes consider all supporting action for them. Get the scenes full of primary and secondary action, this rids them of choppy sequences and helps develop the story. Don't shoot every scene from the same angle. Use close-ups, medium shots and long shots, high angles, low angles, and so on. These are mechanical aids in telling your story. The long shots orient the audience; medium shots center attention on a definite subject first seen in a long shot; close-ups focus specific attention and magnify the impression, thus enhancing the teaching value.

Opportunity shots.—Don't depend on opportunity shots in outlining the shooting script but take advantage of those that will continually show up while you are in the field. Many times you can slip them in for a really good dramatic effect. You are not hidebound by the original shooting script. It is only your working guide.

Choice of actors.—Professional actors are not the best for our type of films. Individuals familiar with the subject and whose physical actions are easy and sure can do a good job under a little good direction. For example, someone who has a lot of practical experience in the use of a Pulaski, saw, or ax, can demonstrate the cutting down of a snag much more realistically than could someone who, although more photogenic, does not have the know-how that comes only with a lot of doing.

Choice of equipment.—Use up-to-date equipment and the latest approved techniques. Don't compromise, for example, on an "old 35" if a new RD–6 is what you want.

Choice of site.—We found that the time taken to pick a suitable site really pays. In this new film, for example, the 2 days required to find a suitable site made it possible to get all the desired shots within a small area, thus cutting down on travel time and other preparation. If your film is to be a fire picture try to avoid the use of oil or other substances to "soup" up the fires. "Souped" fires never look right. Experienced fire men know how normal smokes look. This is another factor that can be avoided by careful selection of a site and timing production to get good burning conditions.

Weather Bureau forecasts.—Good photography requires plenty of sunlight, absence of haze, especially on long shots, and clear days. We depended a lot on our direct contact with the Boise Weather Bureau for forecasts while we were filming this new picture. Luckily we could talk with them by phone over a Forest Service line. Their forecasts materially aided in planning the field shooting and served as a reliable economy measure in hiring additional help.

Animation.—If you have to have animation, hold it to a minimum and plan it carefully to avoid costly reshooting. It's difficult and expensive.

Extra help.—You will usually need some laborers for the rough work. They can speed up production a lot by relieving the production team of setting fires, putting them out after shooting, moving equipment, preparing safe fire lines, and so on. The number, of course, depends on the type of film you are producing. Hold them to a minimum because here again is a cost item that can be controlled.

Technical assistance.—While preparing original working script and doing field work, the production team, especially if it is not conversant with the subject, will find technical advisors sometimes help a lot.

Work print.—By all means, get a black and white work print even though your original may be in color. You can do almost anything with it and won't have to worry about scratches, lost film, breakage, etc. *Guard that original.* All your subsequent prints depend upon it. Careless and unnecessary handling of originals will plague you for the life of the film. Don't run it through the "flicker" or projector if you can avoid it. If necessary to project the original once, be sure the projector is extra clean and loosen up the film gate to ease the tension on the film.

Editing.—Here again we found out how to do it the hard way through trial and error. We estimate it took us about one-fifth the time on the last film for this part of the process as for the first one. This was due to a lot of practical little things that we developed in this work. We will not enlarge upon them here, but would be glad to pass on what we learned to any interested region or agency. The following equipment seems to be about the minimum necessary for editing:

Well ventilated darkened room.
Wall film rack.
Viewer or "flicker." (Greig or Film are good.)
Rewinds.
100-foot reels and some larger 300- or 400-foot ones.
A good splicer, cement and scraper.
Wiping cloth.
Extra leader.
Scissors.
Pen and ink, and grease pencil.
Double-thread projector.

The master script.—The master script is the final written form, revised for recording. Get all the help and advice you feel necessary from skilled writers and regional trainers. The Divisions of Information and Education and Personnel Management can give you a lot of sound advice in wording the narration from the training angle. *Write to the scene and action*—this is important and a timesaver. After getting the script in final form, get some administrator to spark plug it through, preferably the boss whose enthusiasm carried the film to this stage. You will save endless arguments and changes by having him say, "This is it."

We have just touched the highlights of some of the production problems encountered in producing the new film, Forest Smokechaser, and the two others preceding it. It is hoped that the above at least indicates that regions can make pictures, fairly successful ones, too.

Protection of Tool Handles From the Powder Post Beetle.—Over a period several years the following practice in the control of the powder post beetle, in the storage of new handles and of fire tools in caches:

Place the handles in a vat of sufficient length to accommodate them and cover with a mixture of five parts used motor oil and one part kerosene. Allow them to soak for 2 days. Then remove the handles and allow them to dry 1 day in the air before wiping and placing in storage.—FRED G. AMES, *District Ranger, DeSoto National Forest, Miss.*

PROGRESS OF RECENT EQUIPMENT DEVELOPMENT

EQUIPMENT DEVELOPMENT COMMITTEE

U. S. Forest Service

During the United States Forest Service equipment meeting in February many items of equipment being developed by the various Regions were discussed. Short narrative descriptions of each project were prepared and appear in the minutes of the meeting recently distributed to a limited group. Since a number of these narrative descriptions are of general interest, we are including them here.

REGION 1

Bosworth Trencher.—In further development of this machine, the plan was changed to provide for the application of power to the wheels as well as to the digging tool. This is accomplished with planetary gears. The latest model weighs 180 pounds. It has two wheels in tandem, a rotary digging tool with strap iron hammers mounted between rubber blocks, and a 6-horsepower engine. The digging tool is reversible. The fluid drive principle is employed. Different types of digging or sweeping tools could be used. The unit has been designed for dropping from an airplane if desired. From tests made so far, the superiority over hand tools is estimated at 10 to 1. Completion of the second pilot model is delayed by the difficulty of obtaining certain gears. Completion is expected by July 1. The cost in quantity production is estimated at $325.

Iron Mule.—This was described as a powered wheelbarrow, designed to carry loads up to 200 pounds on grades up to 35 percent. It is estimated to weigh 100 pounds and will be suitable for dropping from an airplane. The development is closely related to the Bosworth Trencher and will follow that development.

Scooter.—Region 1 had experimented with a scooter on trails for some time prior to 1945. In that year scooter development was assigned to Region 6. The Cushman scooter appeared to have possibilities for Forest Service work and an Army model was acquired. Certain changes were made in this model to adapt it for trail transportation, and later two commercial models were purchased by Regions 1 and 6. While this scooter is well constructed, tests showed certain disadvantages for use on forest trails. It appeared possible to develop a machine that would weigh less, have a shorter turning radius, and be easier to control on heavy grades and rough surfaces.

In 1946 Region 1 began experimenting with fluid drive applied to a trail scooter. Plans were also worked out for light-weight construction. The latest model weighs 180 pounds. The wheels are 18 inches in diameter over-all, and have 6-inch tires. Ample power is supplied through fluid drive from a light 4-cycle, air-cooled engine. The scooter performs well on horse trails if large boulders are removed and the bad sections improved. It will climb a 45-percent slope with one man. A local manufacturer has become interested in producing a commercial scooter with fluid drive and is willing to incorporate the features needed for trail operation. The cost is estimated at $300. At present scooters are classed as passenger-carrying vehicles. Steps should be taken to get the classification changed.

Aluminum Tanker.—This unit is mounted on a Dodge 4 by 4 chassis. It has a 200-gallon tank, a live reel, and compartments for rubber-lined hose and tools. A two-speed power take-off pump is used. Since the chassis has a power winch the power take-off drives the pump through a gear box. The body, spare tire, and reel weigh 830 pounds. With a full tank and all planned equipment loaded, the total weight is 200 pounds less than the manufacturer's rated gross weight for the vehicle. The aluminum units already constructed cost $2,000 each, but it is estimated that additional units can be produced for from $800 to $1,000 each in lots of 10 or more.

Smoke-Jumper Fire Pack.—This is a one-man fire-fighting outfit similar to a smokechaser's pack, but specially adapted for dropping to smoke jumpers. The development has been completed and the report will be available soon.

Slotted Freight Parachute.—The purpose of this development is to reduce oscillation. Tests made so far indicate that slots in a freight parachute will reduce oscillation materially. Further tests will be made before a report is compiled.

The Baker parachute, which has a center shroud line, has been tested to a limited extent in Region 5. The data will be turned over to Region 1, which will go ahead with the testing and report results along with the information on the slotted parachute.

Disposable Sleeping Bag.—So far no satisfactory disposable sleeping bag has been found, but paper manufacturers are interested.

Duffle Carrier.—The primary purpose of this development is to provide a means of bringing out smoke-jumpers' equipment without pack horses. The first model, which is ready for trial, consists of a Stokes litter mounted on a bicycle wheel. Another model has been designed with a 14-inch wheel to lower the center of gravity. It will be constructed of aluminum tubing, weigh about 36 pounds, and carry up to 200 pounds. It will be collapsible so it can be dropped from an airplane.

REGION 5

Fog Nozzles.—Equipment Development Report No. 11, March 1948, Characteristics of Certain Fog Nozzles, includes a condensed revision of the project report prepared by the University of California, Los Angeles Campus. Ten commercial nozzles of fog and spray type, with various tips, having discharge rates from 3 to 40 gallons per minute, are covered.

Experience on fires on the Cleveland National Forest during the 1947 season indicates very strongly that use of fog type nozzles made water about twice as effective as spray from garden hose type nozzles. Three-and six-gallon per minute fog tips were used in most cases, although 8-gallon per minute tips were available. Garden hose nozzles used in the same fire situations have discharge rates of about 10 gallons per minute.

All low-pressure varieties of fog nozzles tested require a nozzle pressure of about 150 pounds per square inch to produce an effective fog; i. e., mist-size droplets. All have a critical range of pressure, usually from 90 to 130 pounds per square inch, below which they act as a sprinkler, producing a medium or coarse spray. As pressure is increased through the critical range, a larger proportion of the droplets become mist size. A few observers have noticed that the addition of a wetting agent when operating a fog nozzle at the lower end of the critical range will produce, to a certain extent, the same effect as increasing the pressure. Theoretical considerations verify this.

None of the fog type nozzles now on the market fully fills our need but at least two manufacturers are coming out, this spring, with new models designed especially for forest fire work.

Wetting Agents.—The superiority of "wet water," i. e., water with added wetting agents, is believed to be grossly exaggerated. Tests run to date have given contradictory results, because sufficient controls were lacking. Effect of technique and manner of applications apparently are of much greater importance than whether the water carries a wetting agent or not.

The development of this problem indicates several things. First, that more can be gained in learning how to most effectively apply plain water and in training nozzle men. Second, that perhaps the nozzle man is the most important man on a pumper crew, instead of the pumper operator. At least, more attention should be given to training and supervision of the men in whose hands is determined the effectiveness of costly units of equipment and organization. Third, that a series of standard test fires representing principal fuel types must be developed in order to evaluate differences in effectiveness of various wetting agents when applied in the most efficient manner. Obviously, to do this we must first learn by controlled experiments how to apply each most effectively.

The University of California at Los Angeles is now starting on the fundamental work in the above. During July the California Experiment Station and the Arcadia Center plan to run some semicontrolled field tests. These will give us a few quick answers on obvious points. If wetting agents have no obvious superiority, such as greater than 2 to 1, we will have to wait for more accurate determinations with laboratory controlled fires.

While we are waiting for positive proof of wetting agents, it seems reasonable that all regions should use them conservatively on mop-up. The advantages in mop-up are more obvious. If we do this, however, premium prices should not be paid for highly advertised specialty products. Such products have little or no advantage over wetting agents sold for general commercial use. Nearly all wetting agents are toxic, like soap, and nearly all promote rust and corrosion to a high degree. Many agents cause considerable foaming if the solution is agitated in the presence of air.

This particular phase of the use of water and chemical study is now of highest priority and results of tests will be published currently.

Other Chemicals.—Mono-ammonium phosphate (technical grade) is also a useful additive to water. Truax's studies show that a 5- to 10-

percent, by weight, solution is the concentration desired. This can be added to "wet water" to give an obvious residual effect. That is, after the solution has dried the mono-ammonium phosphate will retard, and in many cases extinguish, the fire.

Helicopter Tests.—See Fire Control Notes, January 1948, page 1; and this issue, page 5.

Portable Pumper Tests.—During the past years there has been developed at the Arcadia Center the apparatus and procedure necessary to run development tests on portable and semiportable pumpers, and approval test as required by Forest Service Specifications covering portable pumpers. During the current fiscal year three pilot models of new pumpers were tested, resulting in the development of a new light weight 4-cycle engine-powered pumper more suitable for use with fog nozzles and cotton-jacketed hose. Two other pumpers are scheduled for tests this spring. One is the new Edwards model 120 and the other the Porto pump.

Utility Trailer, Tractor Drawn.—See page 31.

Specifications.—This is a Service-wide project in which the Arcadia Center is collecting information on light alloys and rubber products, and testing procedures in order to improve specifications. It also covers development and testing work necessary to permit the writing of certain specifications and the photographic, drafting, and duplicating work connected with the preparation of all Service specifications.

Tractor Tanker.—Original tractor-tanker experiments were made with tanks and pumps mounted on crawler tractors. These all proved unsatisfactory, since the additional equipment and water reduced the performance of the tractor and interfered with other operations for which the tractor was used. The Army cargo carrier (M–29), better known as the Weasel, was selected in 1946 as the crawler vehicle most nearly meeting tractor-tanker requirements. Testing and use of the Weasel on fires shows that its performance looks very promising. Twelve modified units will be in fire control service in Region 5 this year. From experience with these units it is expected that plans and specifications can be prepared in cooperation with the Portland Laboratory that will give us a currently produced track-laying vehicle for general fire line hauling missions beyond the reach of all wheel drive vehicles. Experience on fires has already shown that the Weasel is so useful for laying hose lines and general hauling that any pumper-tanker equipment should be slip-on. E. D. Report No. 10, February 1948, Tracklaying Fire Line Transport, covers progress to date on this project.

Ram-Jet.—This is a project started in Washington by T. V. Pearson. It involves the use of the products of combustion from a jet engine (or automobile engine) to extinguish fires. The Aero Jet Corp. at Azuza, Calif., is working on it, and the Army Engineers Research and Development Laboratory is interested. In principle it is best suited for enclosed structures.

Tilt-Bed Trailer.—The original project included construction of two different size tilt-bed trailers. Survey of trailers commercially available showed that this was not necessary. Funds were therefore turned back and a small amount reallotted for further survey and preparation of drawings and specifications. Progress is now just under way.

Aerial Fire Suppression.—This project covers the use of spray or dusting type conventional aircraft in extinguishing or retarding the spread of fires. The present desire is to use helicopters instead of fixed-wing aircraft for the same purpose. No work done as yet.

REGION 6

Walking-Type Power Trencher.—This project was assigned in fiscal year 1946 and carried over to later years. The purpose is to provide a light trenching machine which can be handled by one man, with gasoline power applied to both the digging tool and tractor wheels, instead of to the digging tool only, as on the original Bosworth Trencher. All known makes of small garden tractors were investigated and it appeared that none of them was adaptable for the purpose. A trial unit was then assembled and experiments made with different kinds of digging tools. This unit had a 4-horsepower engine, which proved to be too light. However, from experience with the unit, the engineers were able to work out the design and select what seemed to be the best type of digging tools for conditions with which they are familiar, preparatory to assembly of another test model.

The design of the second unit has been completed and its construction is under way. It is expected that field tests can be started as soon as weather and ground conditions permit in the spring. This unit will weigh between 250 and 350 pounds and be powered with a 6-horsepower, 4-cycle engine. Cleated steel tractor wheels 24 inches in diameter will be used. The digging tool will consist of two steel spirals, tapering from 12 inches in diameter at the inner ends to 8 inches at the outside. Each spiral will be 11 inches long to give trench width of approximately 24 inches. They will rotate at a normal speed of 350 revolutions per minute in the opposite direction from the forward rotation of the tractor wheels. Chain and V-belt drive will be used on spirals and wheels. The machine will be controlled with a T handle and power will be used for steering. Forward speeds will be 1 to 5 miles per hour and reverse speeds one-half the forward speeds. Length of machine without handles, 37 inches; width 28 inches.

Firefog Unit.—See page 39.

Disk-Dozer.—See page 19.

Insulated Carton for Keeping Food Hot.—Regions 4 and 6 have used honey cans, in paper cartons, for dropping hot foods to fire fighters (Fire Control Notes, April 1946). Recently Region 6 located an insulated carton which apparently will be satisfactory without the use of a can. It consists of an A-flute corrugated box with special cut flaps and an insulated and water-proofed liner. This type container, in 1- to 60-quart sizes, is in commercial production. The 10-quart size, 10½ by 10½ by 14 inches costs about 27 cents each in lots of 1,000. Food will be put into cold storage locker containers, which are available in sizes up to 1 gallon, as it cannot, of course, be put directly into the carton.

Fire Finder Map.—For many years Region 6 mounted fire finder maps on metal, using the method described in the Fire Control Equipment Handbook. During the past 2 years experiments have been made with maps pressed between two sheets of plastic material. Advantages of this type of mounting are obvious. The trouble has been the tendency of the plastic material to warp. Last fall, a map was pressed between sheets of Vinylite, and exposed on the roof of a building from October 1 to January 1. At the end of the period, it had not buckled nor showed signs of deterioration. A few disks of this material will be tested on lookouts in the 1948 season. The cost will be about $6, but it is expected that a lower price could be obtained on quantity bids.

REGION 7

Pressure-Type Back-Pack Can and Pump.—This project was assigned in 1945. The object was to work with the D. B. Smith Co. in developing a back-pack pump outfit which would conserve water by delivering a continuous stream with greater accuracy, be dependable and simple to operate, and be reasonably free from mechanical defects. Three possibilities for developing pressure were considered: By mechanical means in a cylinder, by mechanical means in the tank, and by pressure cartridge. The first method was selected. Three units were field tested in 1946, in Regions 7, 8, and 9. Reports were considered sufficiently favorable to warrant more extensive tests, and 10 units were distributed in the spring of 1947 to Regions 1 to 6, inclusive.

The can is well constructed of galvanized steel. It has a cylinder in one side, into which water is forced with a pump. A hose leads from the top of the cylinder to a trigger-type shut-off nozzle. In use the operator holds the nozzle in one hand and operates the pump lever with the other.

A summary of regional reports lists two advantages, as compared with the "trombone" pump and can: (1) Better direction and accuracy of stream, which conserves water, and (2) greater compactness, requiring less space in shipment and transportation to the job. Disadvantages reported are (1) too heavy, (2) operation is fatiguing, (3) in operation, the can twists and hurts the back and (4) the handle is hard to disengage from the catch. Another disadvantage in going through thick timber or brush is that, in the carrying position, the movable cylinder extends several inches above the can and may catch on limbs. It was also mentioned that the pump sucks air when the water in the can is below the 2-gallon level.

Suggestions for improvement were to reduce weight by reducing tank capacity and using light metal, to reduce diameter of cylinder, to redesign pump lever and provide some means of preventing the twisting and "sawing" of the can on the back, to use a noncorrosive ball valve, to provide heavier shoulder straps with a carrying clip for nozzle, and to provide a handier pump lever clip.

Insulated Food Container.—This was an investigation of a container used in New England for transportation of fish and lobsters. Its dimensions are 14 by 14 by 26 inches, and the capacity is 40 to 50 pounds of live lobsters, 80 pounds of lobster meat, or 100 pounds of fish. A dry ice unit, 6 by 6 by 12 inches is claimed to hold temperatures from 50° to 20° F. Temperature is controlled by regulating CO_2 pressure. Three pounds of dry ice is necessary for a 24-hour period. Latest price quoted is $1.50 each. This container is not being manufactured at the present time.

Fire Control Tower.—The State of Maine purchased from WAA for $200, 102 feet, or two units, cataloged as "The Wayne Steel Portable Tower for Observation and Triangulation, type B." The steel was purchased for three 34-foot towers, with 8- by 8-foot cab. One has been erected at a total cost of $425. The sides have no batter. The tower is anchored in 14- by 14-inch concrete blocks and secured with ¾-inch cables 65 feet long. An inside stairway was substituted for the standard iron-rung ladder and a trap door was constructed in the roof for safety in making repairs. The tower is capable of supporting a load of 44,000 pounds.

REGION 8

Mathis Plow.—Produced by Mathis Machine Works. This is a 3,300-pound plow, with rolling coulter, middlebuster, and disks. It has been used for some time in areas where a light plow is not adequate. The lift is operated from a power take-off on the tractor. The plow requires a tractor in the D-4 class.

Husky Plow.—Used in Texas. It is a one-man fire fighting outfit consisting of a Husky garden tractor and a wide-angle middlebuster plow. It travels 3½ miles per hour and makes a 36-inch shallow trench.

Hi-Low Trailer.—Built to haul the Mathis plow and tractor. The capacity is 9 tons. It was fabricated from the back end of a truck at a cost of $800 in the Forest Service shop. A folding ramp proved unsatisfactory, so a sliding ramp was constructed. This is on rollers and can be moved by one man.

Tilt-Bed Trailer.—Constructed to haul the HG tractor and Ranger's Pal Plow, so as to save transportation equipment. It has tandem axles and single 7:00 x 16 tires. The axles and wheels are house-trailer type, with Corson coil springs to eliminate side sway. The brakes are electric. The Army pintle hook hitch is used. Cost of the trailer is $600.

REGION 9

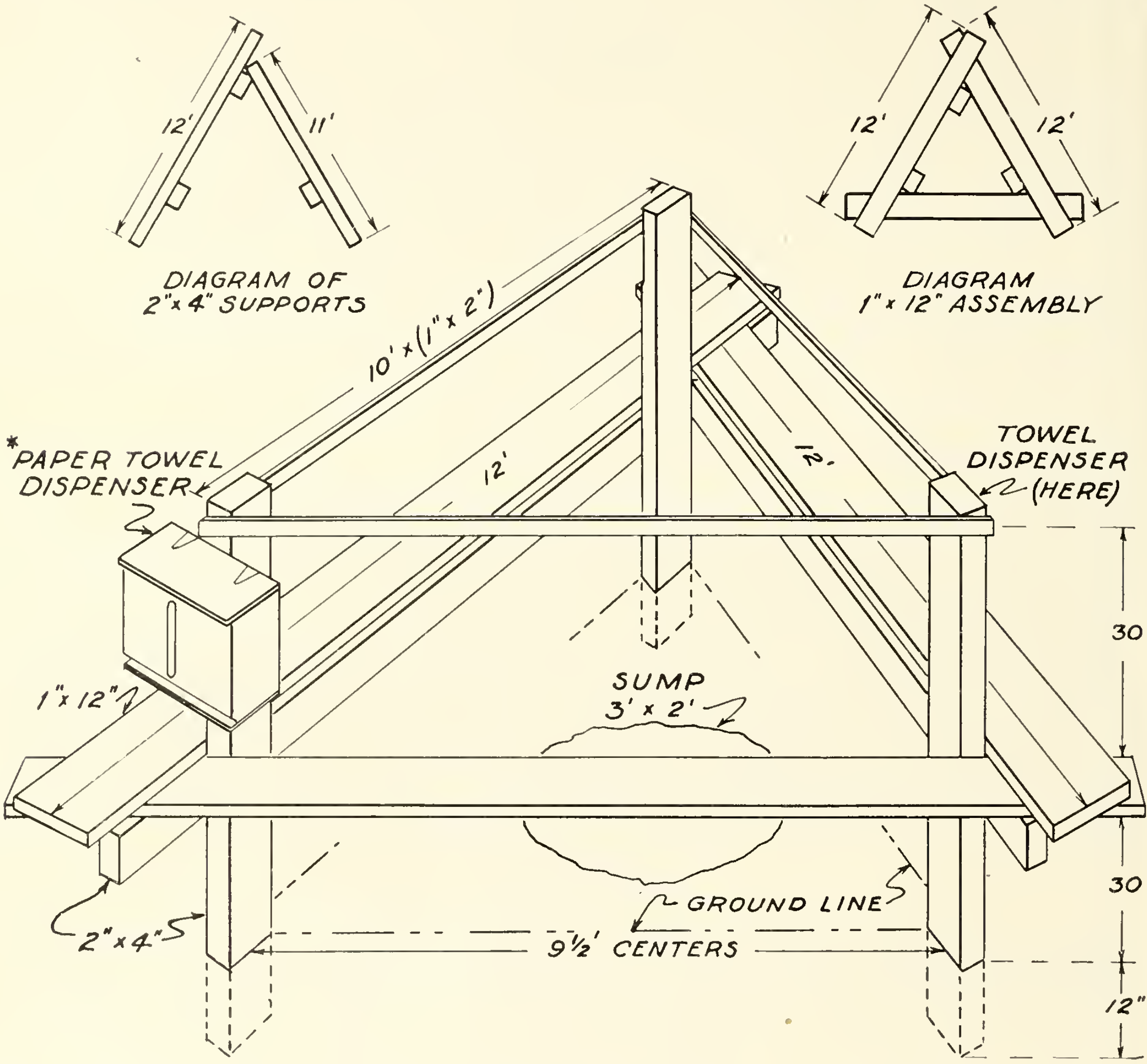
Stubby Plow.—This plow is described in Fire Control Notes, April and July 1947. It is a low cost double-bottom plow, which rides close to the tractor and folds compactly for roading. The bottoms are standard manufacture. The complete plow weighs 255 pounds and can be pulled with a light tractor. It has proved very successful and its use has stimulated interest in mechanized fire-control equipment. Construction of 45 of these plows is now in progress.

Smoke Masks and Goggles.—In testing numerous kinds of smoke masks, it was found that the hospital gauze mask was as good as specially designed smoke masks. Water must be available to keep the mask moist. Goggles with double glass were found to be little better than those with single glass. Each individual should have his own goggles and smoke mask for sanitary reasons.

Rotary Broom Rake.—The Gravely tractor and rotary broom was experimented with for line construction in hardwood leaves. The broom proved to be too long and was shortened, but still consumed too much power and was not very satisfactory. A 20-inch disk with spring tines, such as are used on the International hay bailer, has been constructed but not yet tested. It is expected to require less power than the broom, so that the 5-horsepower Gravely tractor will be adequate at a speed of 2 miles per hour.

Fire Camp Wash Rack.—The wash rack as shown in the diagram has been used successfully and will in most cases eliminate the sloppy conditions which will develop where fire fighters have to wash up.

The installation provides (1) a sump to dispose of waste water; (2) a bench of convenient height for wash basins; (3) rails to support towels, mirrors, etc.; (4) paper towel dispenser (folding, or roll type optional); (5) large cartons or GI cans for waste paper. The paper towel dispenser recommended is the one designed and used by the Plumas National Forest and which holds four to six packages of folded paper towels at a time. Two or more such dispensers are needed per rack.



It will be instantly noted by camp bosses and others concerned with the need for a wash rack, that it can be constructed by using native materials or whatever is at hand. Size, shape, and material specification will make little difference as long as the five functional elements listed above are provided.

The use of slotted strap iron hangers fastened to the bench boards and so designed to slip onto fixed studs set in the posts will do away with the 2- by 4-inch rail supports and provide a permanent and portable rack which can be used repeatedly.—K. McDonald, *Fire Control Officer, Tahoe National Forest, Calif.*

Volume 9 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Address Division of Fire Control
Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE • WASHINGTON • 1948

Contents

Page

Lightning fire discovery time on national forests in Oregon and Washington 1
William G. Morris

Paint for rust 5
George K. Schaeffer

How to meet the hunter 6
O. L. "Lute" Mullenax

Operator training 7
D. W. McFarland

Headfires are cooler near the ground than backfires 8
A. W. Lindenmuth, Jr., and George M. Byram

Dropping supplies from small planes 10
Dean Field and Hubert O. Wilson

Aerial detection on the Superior National Forest 12
J. W. Trygg

Tractor mud tongs 16
Fred G. Ames

Why tote a back-pack pump 17
Elmer F. Petersen

Fuel moisture sticks are accurate 18
A. W. Lindenmuth, Jr., and J. J. Keetch

A Gee Whiz on fire line construction 21
Don L. Gerred

Brush guard and tie-rod protector for the jeep 22
Solon Hyde

Equipment service in the Region 5 emergency fire plan 24
Verl Jeffrey

Broken handle remover for single and double bit ax and Pulaski 25
Division of Fire Control Region 4

Experimental trial of wetting agents 26
Division of Fire Control, Region 9

Huski gardener fire plow 28
R. F. Irwin

Use of SX radio in aircraft 30
Warren E. Barnes

Meeting a fire situation 31
George M. Gowen

Problems of fire protection on reforested strip-mined areas in Indiana 32
S. J. Hensler and J. H. Winchell

Vegetation temperature and fire damage in the southern pines 34
George M. Byram

Higher helicopter limits 37
Wilfred S. Davis

Smoke jumping in the southwest 38
F. L. Jackson

A new fire danger meter card 40
James R. Crowell

Mobile telephone service in cooperative forest fire area 41
J. W. Mattsson

Portable tractor headlights 42
M. D. Stowell

Pocket-size fire control plans 43
Edward Ritter

Demountable transport bed for 50-man fire unit 44
M. O. Adams

LIGHTNING FIRE DISCOVERY TIME ON NATIONAL FORESTS IN OREGON AND WASHINGTON

William G. Morris

Pacific Northwest Forest & Range Experiment Station
U. S. Forest Service

In Oregon and Washington lightning causes 25 percent of the fires on State and private lands and 70 percent of those on national forests where more rugged topography favors lightning-storm development. Although many of these fires occur with rain and are quickly seen and easily suppressed, others cause great damage by smouldering unseen until dry, windy weather suddenly fans them to life in bad fuel types. Knowledge of the experience records of lightning fire discovery times is useful in planning for the load on suppression forces or the period during which extra lookouts and aerial patrols may be productive after a lightning storm.

Several circumstances may affect the discovery of lightning fires. For example, when a bolt of lightning strikes it may hit dry fuel from which flame or smoke may be visible almost at once. On the other hand, it may hit wet fuel which may smoulder for a week or more before becoming dry enough for the fire to gather headway and produce visible flame or smoke. The strike may be in an open forest cover where smoke near the ground can be easily seen or it may be in a tall, dense cover where diffused smoke is hidden until it becomes too thin to be noticed when it finally reaches above the trees.

One source of information concerning lightning fire discovery times is the individual fire report of the national forests. These reports show the time of ignition of each fire as judged from records of the time when the lightning storm passed over the area. They also show the time when the fire was first discovered. Reports for 5,300 lightning fires on the national forests of Region 6[1] during the period 1940–44 were tabulated according to the locality and timber type in which each occurred and the interval between ignition and discovery.

The average percent of fires discovered at various time intervals after the storm occurred is shown in figure 1 and table 1 for Region 6 as a whole. If 1-hour rather than 2-hour periods had been illustrated, the chart would show that 31.2 percent of the fires were discovered in the first hour after the storm. The fires remaining to be discovered after 8 days, the limit of the chart, were 3.5 percent of the total number.

---

[1] Washington and Oregon, excepting the Colville National Forest in northeastern Washington which is in another administrative region. The Olympic and Siuslaw National Forests of the Coast Ranges in Region 6 were omitted because they have very few lightning fires.

TABLE 1.—*Proportion of lightning fires discovered within various periods of elapsed time after ignition, Region 6, 1940–44*

Periods of elapsed time	Percent of total fires
6 hours	50
24 hours	78
3 days	90
7 days	96

Figure 1 shows a decreasing rate of discovery until 8 hours after the storm, then a gradual increase until 16 hours, then a decrease until 32 hours, then an increase until about 42 hours, then a decrease. Both high points occur 8 to 10 hours after the low points. The low points are 24 hours apart, and the high points are at nearly the same interval. No satisfactory explanation of this pattern has so far been found. Since burning conditions and visibility vary with the time of day, the pattern may be related to the proportion of storms beginning at different hours. In such a case, the elapsed discovery times would have to be analyzed according to the hour at which the storm occurred in order to recognize the relationship.

EFFECT OF COVER TYPE

To learn which forest cover conditions may have contributed to differences in discovery time, the kind of cover at the starting point of each fire was classified as either an open canopy or a closed canopy. The discovery times in each class were studied to learn if fires starting in an open forest canopy are usually discovered more quickly than in a closed canopy. The open cover included nonrestocked cut-overs and old burns, small regeneration and saplings, and the ponderosa and lodgepole pine types. For the two States as a whole, discovery times for these types were less than for the closed types. Within 6 hours after the storms, 52 percent of the fires in the open types and 45 percent in the closed types had been discovered. This 7 percent difference remained nearly the same for any given elapsed time from 6 to 48 hours after the storm passed. As a result, 19 percent of the closed-canopy and only 11 percent of the open-canopy fires remained to be discovered after 48 hours.

VARIATION BY SUBREGION

Since there is a great difference in fuel and fire-weather conditions between northern and southern and eastern and western parts of the two States, the fire reports were grouped according to national forests that have similar conditions. The discovery times were then studied to determine if the results previously discussed for the two States as a whole differed appreciably between the forest groups. Part of the

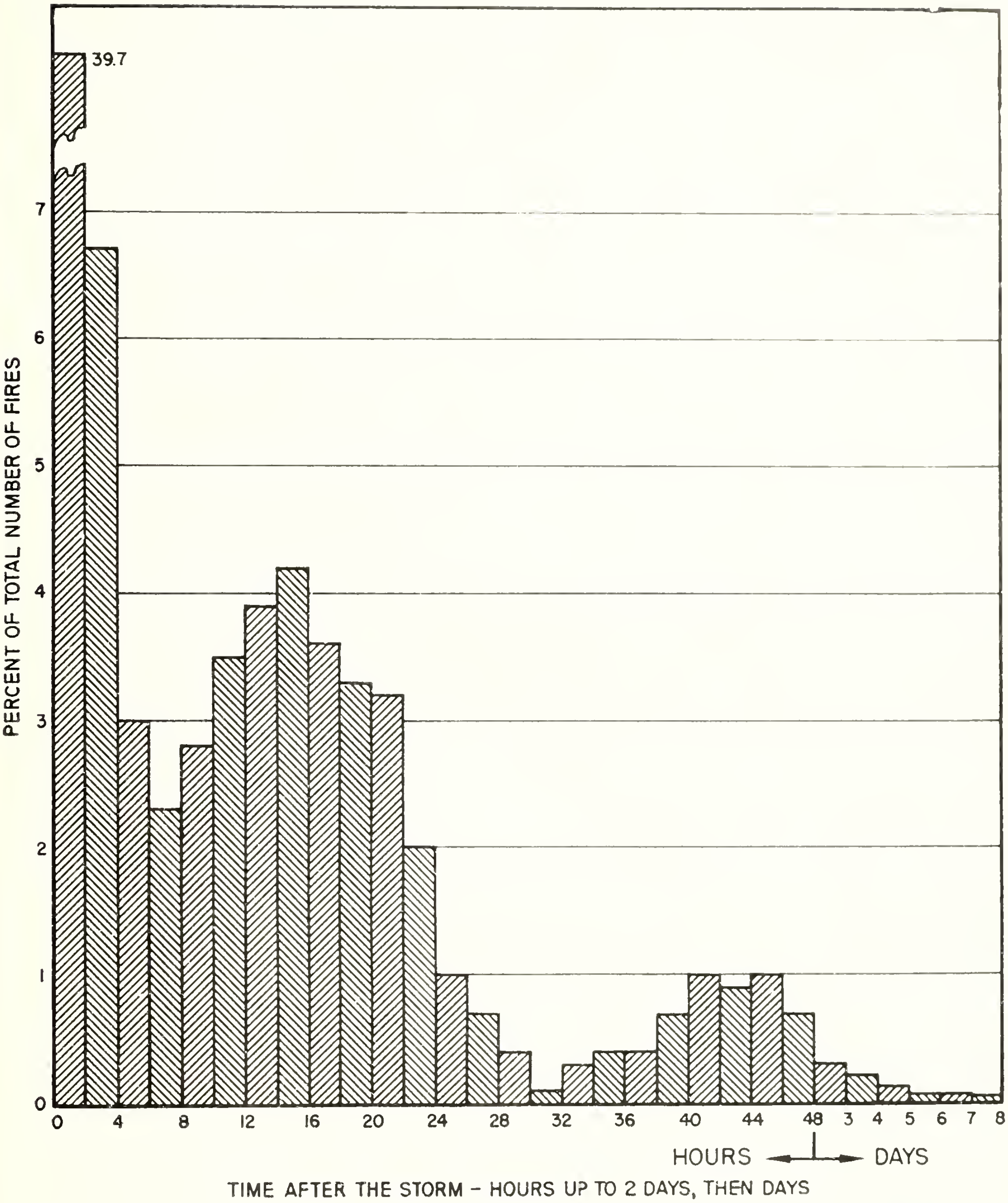


FIGURE 1.—Average rate of lightning-fire discovery at specified periods after storm occurred, for 5,357 fires in Region 6 during 1940–44.

data giving comparisons of the proportion of short and long discovery times in different forest groups is shown in tables 2 and 3.

Except in the Chelan-Wenatchee group, rate of discovery in each group followed a pattern similar to the regional pattern shown in figure 1.

The Mount Baker-Snoqualmie-Columbia group of western Washington discovered a much larger proportion of its fires than did the Oregon forests in the first 6 hours. By the end of 24 hours, however, the relationship was reversed and the Oregon forests had discovered as great or a greater proportion of their fires compared to the western Washington forests. The Chelan-Wenatchee group of eastern Washington discovered a greater proportion of its total fires than did any other group during each elapsed time period between 1 hour and 7 days.

TABLE 2.—*Proportion of lightning fires discovered in each of the first 3 hours after ignition in different national forest groups in Oregon and Washington, 1940–44*

Hour	Washington		Oregon			
	Mount Baker, Snoqualmie, Columbia	Chelan, Wenatchee	Mount Hood, Willamette, Umpqua	Rogue River, Siskiyou	Deschutes, Fremont	Blue Mountain forests
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1st	46	46	28	25	23	23
2d	5	7	9	8	11	10
3d	3	3	4	7	6	4

TABLE 3.—*Proportion of lightning fires discovered within various periods of elapsed time after ignition in different national forest groups in Oregon and Washington, 1940–44*

Periods of elapsed time	Washington		Oregon			
	Mount Baker, Snoqualmie, Columbia	Chelan, Wenatchee	Mount Hood, Willamette, Umpqua	Rogue River, Siskiyou	Deschutes, Fremont	Blue Mountain forests
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
6 hours	59	63	45	44	45	42
24 hours	74	83	74	77	82	78
3 days	86	94	87	87	92	91
7 days	92	98	94	95	99	96

The effect of open and closed forest canopy types upon fire discovery time was studied by forest groups to determine if the effect noticed for the two States as a whole was consistent in all groups. The Washington and western Oregon groups showed the same tendency for earlier discovery in the open-canopy types as discussed previously for all groups combined. But in the eastern Oregon groups the proportion of discoveries during the first 6 hours was approximately the same in both closed- and open-canopy types. This is reasonable since most forests are somewhat open in eastern Oregon, making less contrast between the open and most dense timber types than in Washington or western Oregon. On the other hand, between 6 and 8 hours after the storm the proportion of discoveries increased in the open-canopy type in eastern Oregon. As a result, in the eastern Oregon forests, as in the others, a greater percentage of the fires occurring in open-canopy timber types than in closed types was discovered before 8, 24, or 48 hours had elapsed. This left a greater proportion of the fires in closed-canopy types to be discovered after 48 hours or more in all the forest groups.

CONCLUSIONS

Results of the lightning-fire-discovery-time tabulations indicate that the peak load of discoveries and reports is in the first hour after the lightning strikes. This should be kept in mind when planning for prompt discovery by emergency lookouts and airplane patrols and prompt attack by suppression crews, although weather and visibility are usually unsafe for flying during the first hour. About 50 percent of the fires are seen within 6 hours, 20 percent remain to be discovered after 24 hours, and 10 percent after 3 days. From this it appears that emergency lookouts, patrols, and suppression help may be needed for at least 3 days. The Washington forests have a greater proportion of their lightning-fire load in the first hour than do the Oregon forests. If all fires are to be suppressed as soon as possible after discovery, regardless of locality, emphasis on action as soon as the storm strikes is then even more important in Washington than in Oregon.

Lightning being the greatest cause of forest fires in mountainous parts of all the western States, the applicability of the above results to other western States besides Oregon and Washington should be considered. Results that were consistent in different forest groups within this Region may apply elsewhere and are as follows: (1) The general form of the discovery-time pattern in figure 1. (2) About 6 percent or more of the fires remain to be discovered more than 3 days after the storm passes. (3) In closed-canopy timber types a greater proportion of the fires than in open-canopy types remains undiscovered 48 hours after the storm. The proportion of fires discovered in each hour and within various periods of elapsed time up to 2 days is not likely to apply directly to other States because these proportions varied greatly within Oregon and Washington.

Paint for Rust.—In fire fighting, as in any work, a sharp, clean tool is the best and safest tool. Maintaining such a tool under the Region 8 conditions is a constant fight against rust. We have used oil, grease, and paint of various kinds. Usually the oils and grease are too messy and pick up dirt. The ordinary paint usually blunts and slows a sharp edge.

Until coming to the Francis Marion, I had seen no one method which completely protected and still maintained the full efficiency of the tool. We use Rust-oleum number 634, quick drying, black, on the dry blade immediately after it is sharpened and ready for use. This paint drys rapidly, keeps a good protective coat in storage, and is sufficiently brittle that on use of tool it immediately flakes off leaving a sharp, clean tool.—GEORGE K. SCHAEFFER, *Ranger, Francis Marion National Forest.*

HOW TO MEET THE HUNTER

O. L. "Lute" Mullenax

Fire Control Aide, Monongahela National Forest, West Virginia

Fire Control Aide O. L. Mollenax at a fall fire prevention meeting on the Monongahela National Forest was assigned the subject "How to Meet the Hunter." His presentation of the subject received the hearty approval of the rangers, general district assistants and fire control aides present. The group immediately suggested his talk be reproduced in Fire Control Notes.

Some readers may feel this article presents elementary principles already practiced by everyone in the Forest Service who has occasion to contact people. However, if it does no more than assure doubtful readers, especially new employees, that this is the Forest Service way, it will be worth presenting.

"Lute" Mullenax is one of the veterans on the Monongahela, having worked intermittently on the Greenbrier District since its beginning in 1926. Naturally gifted with the knack of making and keeping friends, and a type who is very valuable in on-the-ground public relations work, he is well qualified to speak on everyday public contacts.

Putting yourself in the other fellow's place is a pretty good rule when you are trying to figure out a course of conduct. In other words, I'll suppose that I am the hunter. I want to be treated with respect and courtesy when I come into the national forest on lawful business. After all, I can say that you fellows are kind of working for me. To be serious, I feel that I am entitled to respect, courtesy, and consideration. Really, I am a guest of the Forest Service. If you come to my home, it is my duty to welcome you and try to make you feel at home. Don't you think that a forest officer should approach a hunter on this basis?

On the other hand, we as forest officers have certain things which should be understood and accepted by the hunter. For example, last spring (and the fact that it was a fisherman rather than a hunter should make no difference) I encountered a fisherman camping on Little River on the plantation side of Little River Truck Trail. Here was a situation which called for some action. The fire was built in a prohibited area. The camper was having breakfast. I greeted the fellow, identified myself, inquired about his luck and "batted the breeze" for probably 5 minutes. I then asked him if he had a camp fire permit. He said, "sure," and presented it without further urge. I noted that the permit stated that the location of the camp fire would be on Little River south of Middle Mountain Truck Trail. Actually the camper was right but I had to get his fire across the road from the plantation. I explained to him that the permit meant that the fire would be built between Little River and Little River Truck Trail. He was apologetic and offered to put the fire out right away. I told him to finish breakfast and then we'd put the fire out. He could build his noonday fire below the road. Incidentally, I enjoyed a cup of coffee with him. I left this man with the feeling that we'd enjoyed each other's company and were friends. This, I think, is the test of a good contact; gaining your point and also a friend.

Here are the rules I would set down for meeting the hunter:

1. Meet the hunter with a smile, not a growl.
2. Let him know who you are.
3. Give him the impression that you are interested in his sport and welfare and want him to enjoy himself. In other words, you are glad that he is there.
4. Try to be helpful to him rather than a nuisance.
5. Don't go into lectures or instructions or preaching unless the circumstances indicate the need. In other words, if he has built a fire properly in a safe place, compliment him, don't go preaching about how to build fires in safe spots.
6. Steer him our way rather than try to order him around or regiment him.
7. Don't impose yourself on the man. There are times when you can sit down and have a nice long visit but there is also a time when he is anxious to get to his hunting. This is a matter of judgment.
8. As soon as you leave you'll know whether you have both gained your point and gained a friend. If you are not sure, figure out how you could have made the contact better.

Operator Training.—Recognizing the need of operator training, the Divisions of Personnel Management, Fire Control, and Engineering in Region 5 have inaugurated an operator training program during the past year. Driver trainers who are skilled in equipment operation and safety are furnished through the Equipment Service Section of Engineering on a request basis to the various forests.

Each operator is given a driver's safety examination which consists of questions taken from the R–5 safety examination with some pertinent questions added. In addition to the written examination, the operator is put through a series of tests to show physical aptitude including foot reaction, field of vision, and depth of vision. He also participates in the oral examination and discussion covering driving rules, courtesy of the road, etc. Finally he is given an actual field test driving the type of vehicle for which he is being qualified.

A record is kept, not only of examination grades made by equipment operators, but notes are also made regarding reaction, vision, and results of the driving tests. All such records are turned over to the operator's superior officer with notations as to whether the operator should have more training, is qualified to drive, or has been disqualified and for what reason.

Special instructions and tests are given to operators driving specialized equipment such as fire tankers, pumpers, and tractors. After the original or first-of-the-season training schedule has been completed, the driver trainer concentrates on follow-up training of tanker operators not only in the operation of the unit but also in the care, lubrication, maintenance, testing, and adjusting of machines insofar as the particular operator is capable.

In facilitating the driver-trainer program, the chief driver trainer also certifies qualified personnel on the various forests as on-the-job driver trainers to take care of on-the-job testing of new personnel or replacements. The chief driver trainer on follow-up trips checks the qualifications of new operators when requested or the occasion and circumstances demand.

Whereas, this program was originally designed and justified on the basis of safety, it has been found very beneficial from a standpoint of obtaining proper use and care of automotive equipment and probably could be justified on the basis of its effect in lowering the maintenance costs of that equipment.—D. W. McFarland, *Area Superintendent, Arcadia Equipment Depot, Region 5, U. S. Forest Service.*

HEADFIRES ARE COOLER NEAR THE GROUND THAN BACKFIRES

A. W. Lindenmuth, Jr., *forester*, and George M. Byram, *physicist*,
Fire Research, Southeastern Forest Experiment Station

Temperature measurements of fires burning with and against the wind in the longleaf pine type on the Francis Marion National Forest in South Carolina indicate that headfires create cooler temperatures near the ground than backfires. This difference is important in the management of longleaf pine, because seedlings infected with the brownspot needle disease must be burned before they will start to put on height growth. These seedlings are usually in "the grass stage," less than 6 inches high. They will remain that size and virtually starve to death unless the infected needles are burned off. Thus, in a longleaf burn, attention is focused close to the ground. In contrast with burns in other species, fire in longleaf is expected to benefit, rather than kill, the seedlings.

To facilitate prescribed burning in longleaf, fire intensity measurements in the low zone were commenced in May. Because liquid thermometers cannot measure flame temperatures that run as high as 1,500° F., thermocouples were used. These were designed to integrate the effect both of temperature and its duration. This combined effect (in other words, the thermocouple reading) may be called the heat factor. It tends to be lower than the actual temperature, but rises with the length of exposure. This rise in temperature of vegetation will be proportional to the heat factor, the exact proportion varying with the size of the vegetation. It is this heat factor that determines the amount of scorching, leaf consumption, and mortality.

Observations shown graphically in figure 1 indicate that the maximum heat factor varies in the proportion of 1.25 for backfires to 1.00 for headfires. Also, maximum heat factor in both types of fires is reached at about 5 inches above the ground. Up to some 18 inches above ground, the heat factor of backfires continues to be higher than that of headfires. Beyond this point, as shown in the figure, the heat factor of headfires is higher. The actual point where the curves cross is at present tentative, and further field work may shift the location significantly.

The reasons for the heat factor differences in the two types of fire are unknown and probably complex. Both convectional and radiant heat are involved. A partial answer, supported by visual observations only, may be that in headfires combustion occurs at a higher level above the ground and that the fire line advances considerably faster.

The value of these tentative results will be tested in field trials. Ranger Koen, Fire and Improvement Unit, Francis Marion National Forest, who had anticipated the results, is carrying out a planned

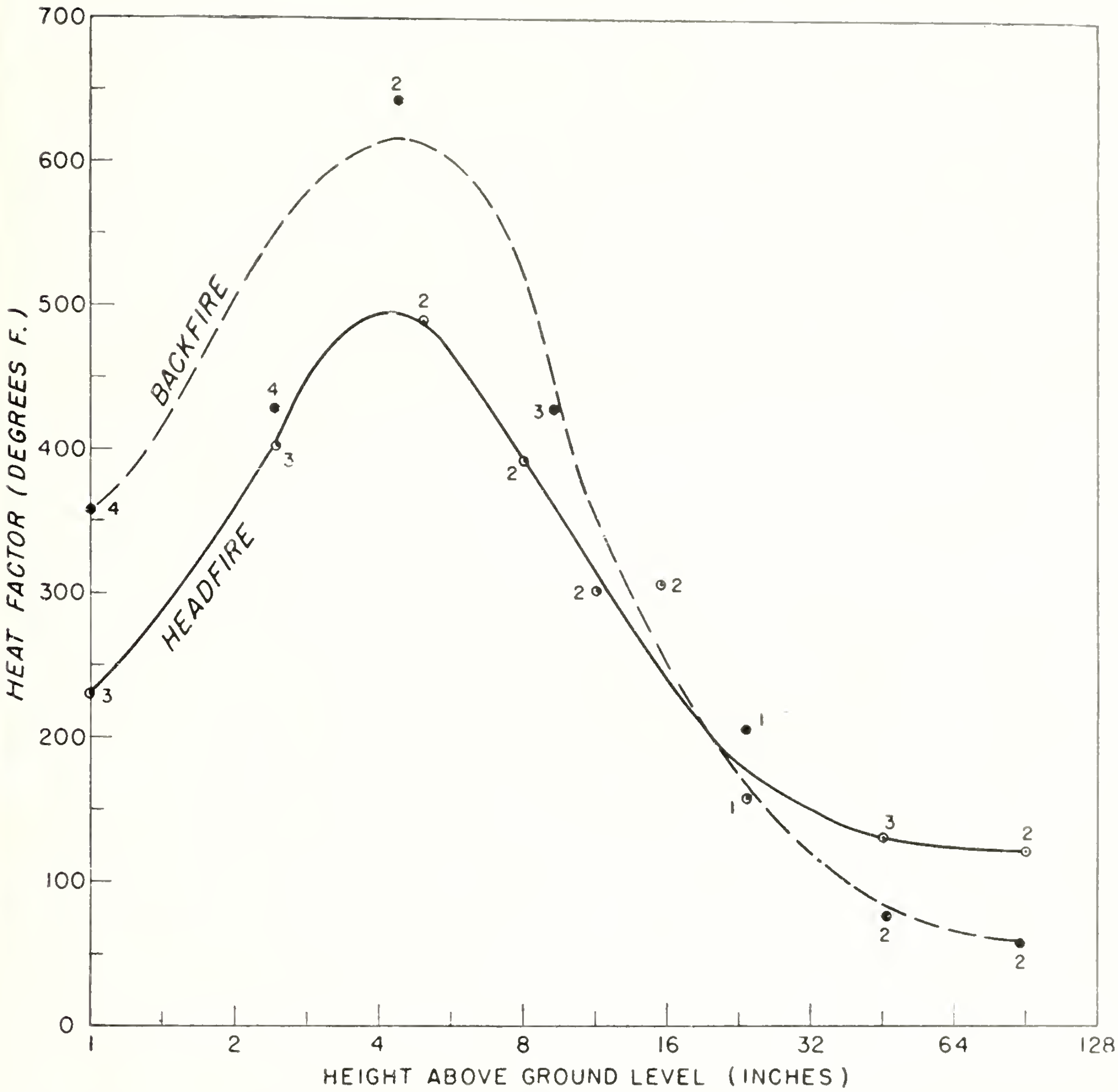


Figure 1.—A comparison of the heat factor associated with backfires and headfires, as measured at varying heights above ground level. Actual flame temperature is approximately 1,500° F.

burning program on a small scale to find out what use can be made of the information. In prescribed burning where it is desired to minimize damage to reproduction under 18 inches or so in height, headfires may prove more economical and effective than the backfires now so commonly used.

DROPPING SUPPLIES FROM SMALL PLANES

Dean Field, *Pilot, Western Washington Aircraft, Inc., and* Hubert O. Wilson, *Fire Staff Assistant, Mt. Baker National Forest*

We thought larger planes carrying a dropper were necessary in past years when supplies were dropped on fires; however, there are few ships of this size at the small airports that are available for our use. Two-place planes, with the pilot doing his own dropping, have been used with much success for servicing fire crews and lookouts on the rugged Mt. Baker National Forest. The small ships can maneuver in a smaller space and get down over small meadows in the valleys where a larger plane cannot. They have a slower cruising speed; therefore, it is easier to drop packages close to target.

Using only a pilot, we dropped 20,610 pounds of supplies in 1946 and 1947 from small planes. An average of five 40-pound packages were dropped each trip.

Dropping procedure for the pilot.—After dropping a package on the target, climb for a little altitude toward an open area so that you will not have to bother with flying the plane to any extent during preparation for next drop. Pull in the static line and tie to the rope ring of the next package to be dropped. Pull the package up over your shoulder and onto your lap, then ease the bottom of the package to the door and hold package by the top (fig. 1). When package is far enough out so that it is just tipped outward yet resting on door frame, it can then be held easily with the door frame supporting the weight, yet a slight push will send it down. Check the static line to insure its being free of rudder bar, stick, and other controls. When plane is in proper position, speed, and altitude over target, tip the bundle over the door frame and let it fall. Usually pull up and turn sharply so as to view the bundle falling to see if any change of timing is necessary for accuracy.

Safety factors.—Use clean sacks so that dust or other particles will not get into the pilot's eyes.

See that the static line is not fouled before dropping package.

Carry a knife to cut static line if necessary.

Fly another round if you are not in position to drop accurately; lost food does not help the fire fighters.

Keep tail high when package is dropped, throttle slightly retarded and maintain cruising speed by slight glide. Do not dive on target.

The food and supplies are packaged in a regular burlap feed sack, with a 13-inch-diameter disk of ¼-inch plywood in the bottom. A 7- by 7-foot burlap chute, with the shroud lines tied to the top of the sack by a square knot, is used. The chute is rolled with the shroud lines inside and tied with a 20-pound-test string to hold the chute roll.

These strings are sewed through the package sack with a sack needle and tied around the end of the chute roll. The string is passed through a rope ring (Molly-Hogan). A second string is sewed through package and tied around the other end of the chute, also going through the ring before tying. The static line that is fastened to the seat strut is tied to the rope ring. When the package is dropped, the rope ring breaks these string fastenings and pulls the chute out and open by another short string that is sewed to the chute apex and tied to rope ring. The package and chute float down leaving the rope ring on the static line.

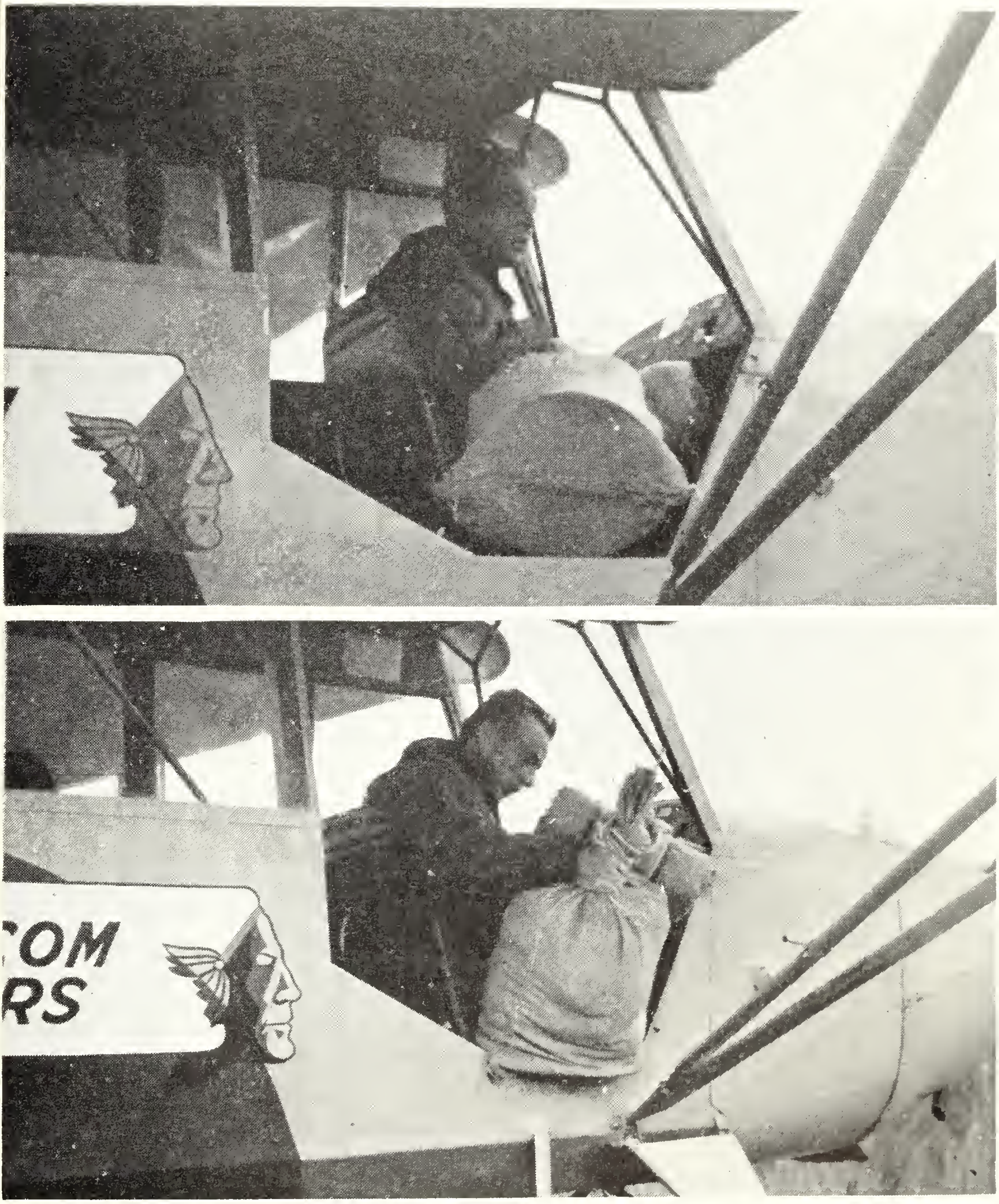


FIGURE 1.—Dropping procedure: Upper, package and chute pulled from back seat; sack placed on door sill with chute inside plane; lower, package pushed out and downward as slip stream catches it.

AERIAL DETECTION ON THE SUPERIOR NATIONAL FOREST

J. W. Trygg
District Ranger, Superior National Forest

As we look back some 18 or 19 years, it is easy to see how inadequate our basic fire organization really was compared to our present day system. It was only a few years ago on the Superior National Forest, when the spotting and locating of fires through the eyes of the lookouts seemed to be perfection in fire detection.

The dispatcher at the district headquarters, acting largely upon his experience and intuition of how "bad" the day was to be, would line up the usual initial attack crew of 10 men equipped with hand tools and food supplies. When a fire was reported by a lookout, either by direct or relayed telephone message, the crew would start on its way, traveling by truck, boats, canoes, and on foot. A day or more was often spent in finding the fire. All this time, the fire burned on. As it grew, more reports were received from the lookouts and more men were dispatched only the disappear in the silence of the forest just as the first crew had done. No one at headquarters knew where the fire fighters were or what they needed.

Following World War I, flying became a pastime and private seagoing planes appeared on the lakes of the Superior. By 1929 it was possible to hire private planes to reach the otherwise inaccessible back country of the Forest. About this time the Forest Service realized the practicability of using planes for fire reconnaissance and during the next 6 years this practice was followed. The value of planes in fire work is indicated in the following narrative from the writer's personal experience some years ago:

> As the lookout watched he saw a seaplane go by on its way to locate a smoke he had reported about an hour ago. In a few minutes the plane was returning the ranger and his smokechaser to headquarters with complete information about the fire. As the fire was already running, the ranger decided to send the smokechaser back to the fire with a pump operator, pump, and 800 feet of hose. The ranger felt much relieved at his action, yet he wondered if enough hose and men to handle the pump unit had been sent. If not—there wasn't room in the plane for more men and equipment—he knew it would take less than an hour for the pilot to return to headquarters for an extra trip.
>
> The plane took off. After arriving at the fire the pilot had to help set up the pump and string out the hose. Within 15 minutes the head of the fire was stopped and the pilot was on his way back to the ranger station for additional help.
>
> On the way back to the fire with three more men, two other fires that the lookouts had not seen were spotted. When the plane landed, the pilot reported the fires to the smokechaser. As the first fire was under control, the pump operator and one man were left to mop up and patrol. The pilot put his plane down on a small lake since one of the two new fires was only 100 feet from the shore. After leaving his last two men on this fire the smokechaser was piloted over the third fire which was about a mile away. This fire proved to be a lightning strike in a

dry snag, and since there had been no rain with the lightning it might cause trouble. Knowing that the ranger had left his station to direct a 20-man crew overland to the first fire and also that all reserve manpower on the district had been dispatched to a large fire on an adjacent district, the smokechaser landed, walked across country for a mile, and alone extinguished the burning snag.

Through this and several similar incidents the Forest realized the use to which airplanes could be put in fire detection and suppression and in 1934 hired its first amphibian-type contract plane. This plane did not prove satisfactory. From 1935 to 1939 the Forest used a pontoon-equipped 4-place Stinson. While the Stinson proved to be a very good all around craft and satisfactory for initial action on small fires, it was not adequate for heavy cargo service.

In 1941 a Piper Cub was purchased and equipped with pontoons. In 1944, because the Stinson had been totally wrecked in a take-off accident, an 8-place Noorduyn-Norseman pontoon plane was purchased. This solved the cargo problem. The larger plane has worked out very satisfactorily as a capacity cargo transport and withstands the rigorous landings on rough waters.

The results of fire detection through the use of these planes led to the proposal of a detection experiment. The specific purpose of this experiment was to determine first, how effective aerial detection would be compared to that of regular lookouts, and second whether towers could be replaced entirely or whether a combination of the two systems should be used. The experimental detection was started in July 1945, and, with some changes, is still continuing.

In planning the use of aircraft for detection patrols, recognition should be given the elements that may disrupt the schedule of flying or affect visibility. These elements could well be listed as follows:

DISRUPTING ELEMENTS

Rough flying weather which taxes the physical stamina of the pilot and observer.

High winds causing exceptionally rough water on landing areas.

Time used for mapping a fire when located, and intensive checking of certain areas because of concentration of forest travelers, lightning storms, or other special risks.

ELEMENTS AFFECTING VISIBILITY

Reflected light on smoke, depending on overcast sky or shadows.

Position of sun. A wider coverage can be patterned when observation is toward sun.

Confusing haze with smoke.

Color of background.

Time of day. Evening glare and shadows.

Effect of wind on smoke rising above tree tops. Smoke is difficult to see when plane is directly over it.

Speed of plane.

The experimental detection area embraces approximately 1,000,000 acres. This area was previously covered by eight primary Forest Service towers as well as one Canadian tower and three State towers manned infrequently. The direct seen-area coverage from all these towers was less than 25 percent. A seen-area study that had been previously made indicated the need for 6 more primary towers, plus a large number of secondary points for periods of low visibility to get less than 40 percent coverage. Instead of constructing these additional installations, aerial detection was immediately instituted as the primary detection system and the existing towers retained as supplementary.

We now own three pontoon planes and have two regular pilots to fly them for the particular type of service desired. Flight circuits are predetermined to obtain an established pattern of coverage. The smallest plane, a 2-place Cub Coupe, is largely used for detection patrol, and is routed over the shorter circuit so that it can return within a short time. A 4-place Seabee is scheduled for the longer circuit. The third plane, an 8-place Norseman cargo craft, is used when it is necessary to fly initial attack crews and cargo to fires. The aerial service is further augmented by employing private aircraft for emergencies or whenever the Forest Service planes cannot handle the full task of aerial detection and suppression transport.

A number of conclusions have been reached as a result of the experiment.

Aerial detection is superior and more efficient than fixed towers in all cases where fires will remain in an incipient stage to allow for less frequency of detection. A sizeable degree of risk may also be allowed since an aircraft will provide more complete and accurate information upon which to base suppression action.

Fixed towers give more continuous coverage at more frequent intervals. In aerial detection this loss in frequency of detection is offset by the more complete direct seen-area coverage which makes possible earlier discovery after a fire occurs in flash fuel types.

Fixed towers have a pattern of detection time over high risk areas. Aerial detection offsets this because it is sufficiently flexible to allow for more frequent coverage. Furthermore, aerial detection is adjustable to cover changes in these risk areas within seasons and year-to-year changes in fire occurrence zones.

Fixed towers have a distinct advantage in immediately detecting fast starting fires in light flash fuels or slash areas. Under such conditions aerial detection will have to supplement these towers during periods of low visibility.

Since the pontoon-equipped plane serves as a type of watercraft, it immediately replaces the expensive power boats previously considered essential for travel over large bodies of water. Likewise, the number of other watercraft normally used for transporting crews to and from fires for other fire control work can no doubt be reduced to a minimum. The same situation has developed for other equipment, particularly in outlying fire tool caches.

Greater efficiency can also be accomplished in providing supplies, food, and materials for suppression crews.

In comparison, the direct cash outlay for airplane detection shows a substantial saving over the old method of tower detection and all that went with it.

In regard to whether or not towers could be entirely replaced or a combination of fixed and flying detection should be used, the following seems pertinent: Our experimental detection project has been operating on the basis of using aircraft as the primary detectors, while lookouts have served to supplement them. A failure in carrying out the schedule of flights and obtaining sufficient frequence in detection coverage obviously weakens the system. The manning of towers in key locations in areas of high risk, as well as where broad extensive coverage can also be made, serves well to offset the risks that may be prevalent when aircraft are not in flight. This has been resorted to during periods of high hazard. Such a system can be justified when a high frequency fire occurrence may be patterned within the seen-area field of the towers. Otherwise there is a duplication of detection unless areas covered by the tower are eliminated from the aerial zone.

In addition to all that has been revealed by the experiment, we have found that positive and reliable radio communication is absolutely essential to efficient detection service. Without such communication we lose all the advantage that has been gained through fast discovery by air. It is further essential that the central dispatcher or base of operations responsible for directing patrols maintain up-to-the-minute information from the observer and to correlate other flying needs.

Also, the basic qualifications and adeptness of an observer must be previously ascertained. His age and physical make-up will determine his ability to perform under all conditions, especially those of unusual physical strain that are frequently encountered. He must have good eyesight. He should preferably have had flying experience so that he has a proper perception of things he has to recognize from the air. A knowledge of the general formation of terrain, timber, and forest fuel types is essential. He should also be able to read maps, interpret aerial photographs, calculate the size of fires, and understand the operation and maintenance of a radio set.

As for the pilot, he must know from experience the comparative limitations he is up against because of the variety of situations and flying conditions. The operational problems of landing and basing aircraft on the waterways of the Superior region are unique in themselves. Each lake used as a landing base has its own peculiarities such as the effect of air pressures, and wind currents. The effect of wind on the water surface makes landings and take-offs uncertain at all times. The characteristic geological formation of rocky irregular shore lines and the elevations of surrounding hills and timber create major problems in landing on an unobstructed and safe flying strip. In short, the pilot must have "bush-born" experience with pontoon-equipped planes if he is to operate safely over the Superior country.

What the future holds for detection and suppression from the air is not all imaginary. The possibilities of the helicopter have already been proven. Fire fighters dropped from the air have passed the pioneering trials. Radio communication is being constantly improved. Water bombing and dry-iced rain are in the experimental stages. We might, however, well imagine future fire control fields involving radar detection and fire observance through televised portrayal. I wonder if 18 years from now we will think of our present detection system as antiquated as our present knowledge tells us our system of 18 years ago really was. Only time will tell.

TRACTOR MUD TONGS

Fred G. Ames
District Ranger, De Soto National Forest

The tractor mud tongs were developed on the Chickasawhay District to help fire plow tractors, mired during fire line construction, out of bogs and marshy places.

The mud tongs, developed for HG Cletrac tractors, are used in sets of two, one for each track, and a set is carried on each tractor as part of its standard equipment. They are easily put on and taken off the track shoes.

A tong consists of two hooks, each made of 3/8- by 3½-inch flat iron and curved at one end to form a short flange, connected with about 2½ feet of 3/8-inch log chain (fig. 1).

A short distance from each hook a cold shut connects the chain so that a loop is formed in the chain. The cold shut serves to hold the hooks in place on the track shoe. It should be at such a place on the

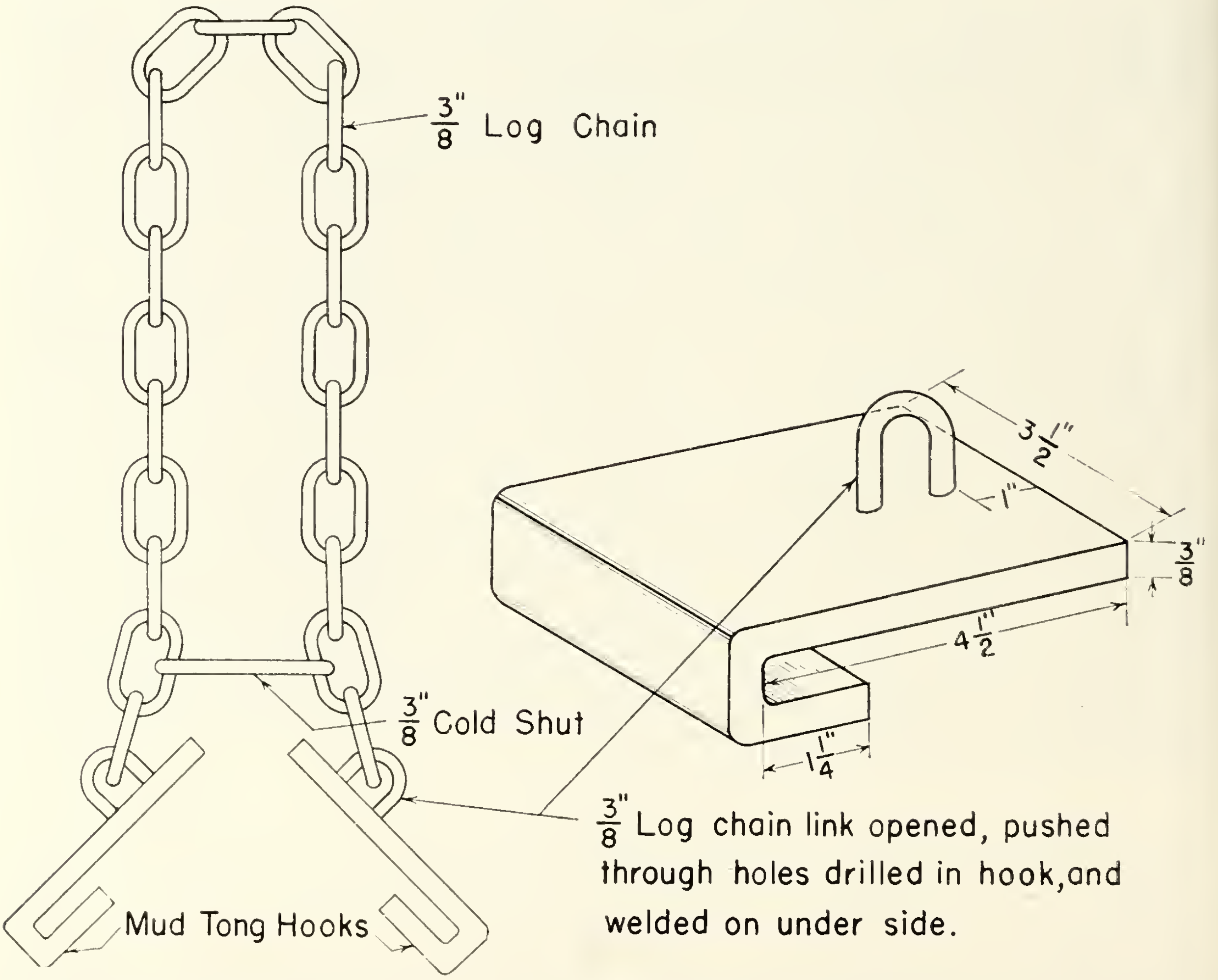

3/8" Log Chain
3/8" Cold Shut
Mud Tong Hooks
3 1/2"
1"
3/8"
4 1/2"
1 1/4"
3/8" Log chain link opened, pushed through holes drilled in hook,and welded on under side.

Figure 1.—Tractor mud tong. Log chain loop should have an odd number of links so that loop will not have a twist.

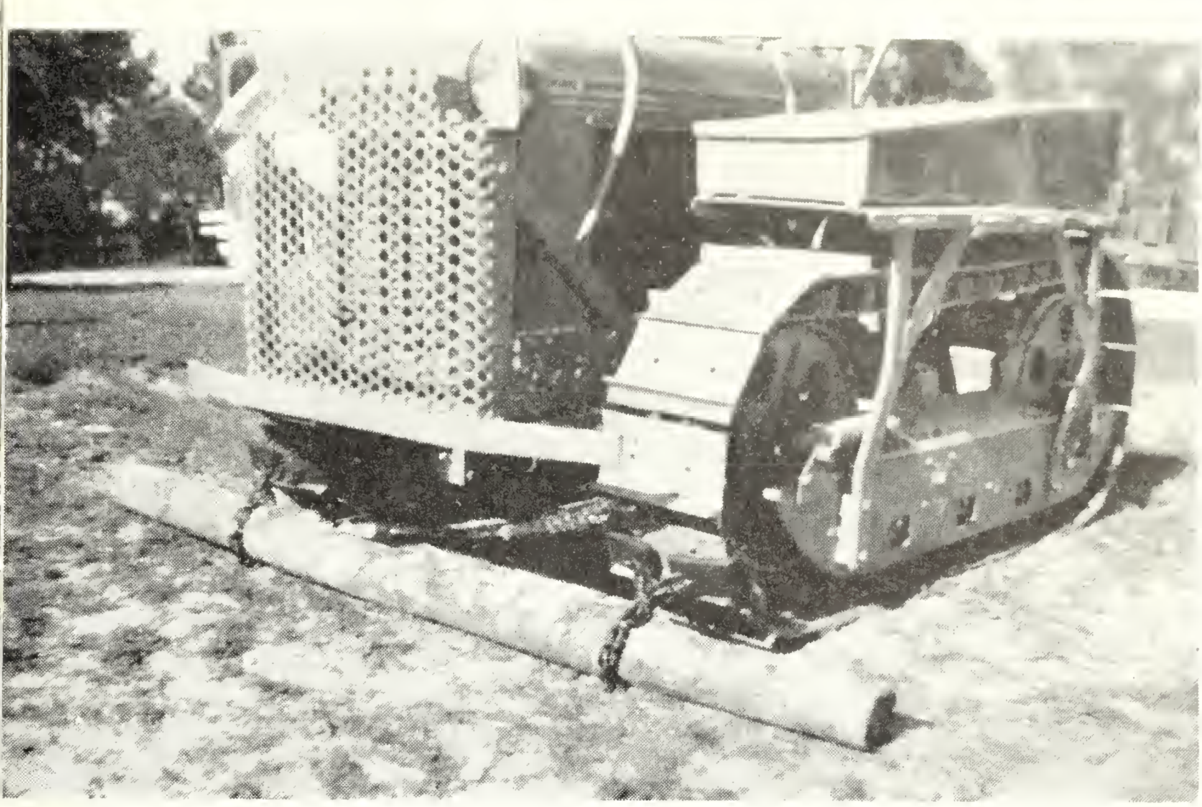


FIGURE 2.—Tongs in place with pole through chain loops.

chain that when the hooks are spread they will barely slip over the track shoe.

When the tractor mud tongs are attached to the tracks and a pole run through the chain loops, the tractor can be made to ride itself up on the pole and out of the mire (fig. 2). This method of riding a mired tractor out of mud is not new. But by use of these mud tongs much less time is consumed than by the use of the conventional pole and chain.

Why Tote a Back-Pack Pump.—Experimentation with a hand pump taken from a back-pack outfit, attached with fittings to a ½-inch garden hose 25 feet in length, the other end of which is attached to a valve fitted into a 50-gallon drum filled with water, proved that where a power pump is unavailable hand pump pressure can do a fairly good job of water dispersion.

For patrolmen or firemen pick-ups and jeeps, a 50-gallon drum of water secured in the bed, a 50-foot coil of garden hose, and a hand pump make action on small accessible fires convenient. A good supply of water is available and more freedom of motion is allowed.

With the 25-foot hose, the hand pump worked as efficiently 12 feet above the source of water supply as on the ground.—ELMER F. PETERSEN, *District Ranger, Sequoia National Forest.*

FUEL MOISTURE STICKS ARE ACCURATE

A. W. Lindenmuth, Jr., *Forester, Fire Research, Southeastern Forest Experiment Station*, and J. J. Keetch, *Danger Station Inspector, Region 7, U. S. Forest Service*

Occasionally man's "better judgment" causes him to doubt the contributions of the devices or techniques now a part of our present civilization. Distrusting the compass when lost, for instance, is a good example. Such lack of confidence is not necessarily confined to the novice. It occurs from time to time also among the experienced, particularly in uncommon situations.

A system of fire danger measurement using Appalachian or slat type fuel moisture indicator sticks is a commonly accepted technique in use in the East and South from Maine to Texas. It is almost inevitable that sometimes under such a wide range of conditions the indications of the sticks at one or more of the 414 stations will conflict with the judgment of the observer or fire control officer. As complete confidence in the observations is essential for effective use of danger measurements, such doubts should be cleared up as soon as possible. The fire control officer wants to know that on a day like last April 18, when the moisture content indicated by the sticks varied less than one percent between Airey Tower on the Gulf in Mississippi and Ossippee Hill down East in Maine, that the effect of all the factors influencing fuel moisture content at those widely separated stations at that particular time was the same.

The fact is that the behavior of any single set of sticks compares and can be checked with an average of many sets. Curves showing the average effect of the two major variables of temperature and moisture content of the air provide a handy yardstick for this purpose. Such curves are available for limited conditions and a portion of them are reproduced here (fig. 1).

Strictly speaking, the temperature used should be an average of that of the upper and lower surfaces of the sticks. However, to avoid technical difficulties, an acceptable estimate can be obtained by exposing a regular mercury thermometer on top of the sticks for about 5 minutes. The result might be called the temperature on the sticks. Relative humidity, due to its general acceptance, is a convenient measure of the moisture content of the air.

On-the-spot checks were made with that technique in West Virginia last spring during station inspection and observer training. The data are shown in table 1.

At Sharp Knob on April 21, the wide range between actual and estimated moisture content indicates that something was radically wrong. A rain of 0.03 inch had fallen the night before. Conditions naturally were changing rapidly that morning. Under such circumstances the surface fuel moisture and the stick moisture were not in balance with their surroundings. Relative humidity provides a poor estimate at such times, so a period when conditions have been stable for some time should be chosen for checking.

The effect of wind on fuel moisture content is complex, but indicator sticks provide a simple means of measuring it. These observations expose two of the limitations of the procedure, as well as suggest two good reasons for continuing to use indicator sticks.

Another approach may be made by determining the actual moisture content of the surface litter and comparing it with the figure in-

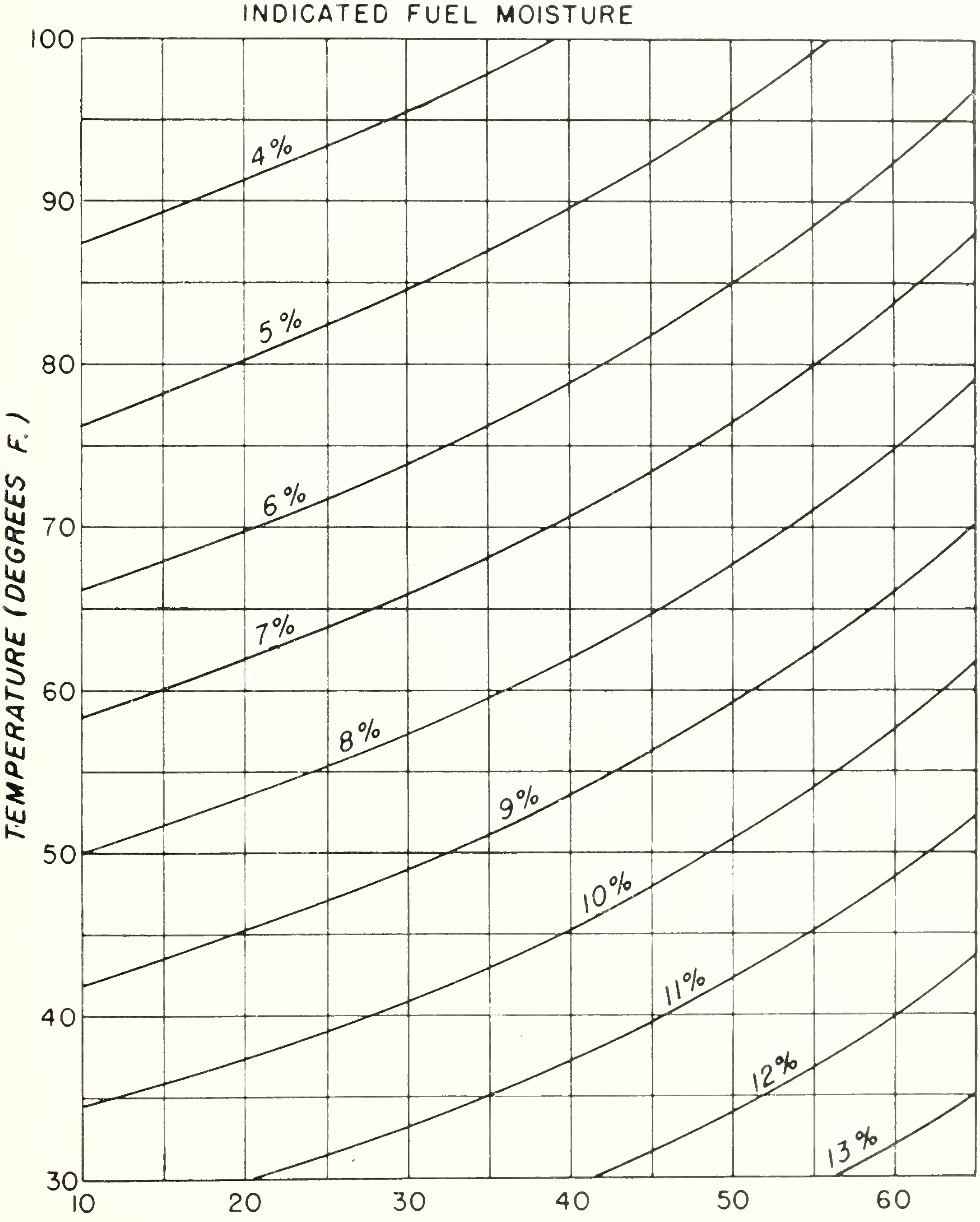


FIGURE 1.—Relation between the moisture content of slat type indicator sticks, temperature, and relative humidity under natural forest conditions during cured and transition seasons.

dicated by the sticks. This is a difficult job, particularly in pine country. Considerable care must be exercised in gathering samples to get only dead litter and only the top layer. Pine needles are inclined to intermingle with lower layers.

Surface litter samples taken on the Francis Marion National Forest in South Carolina on April 27 at 1 p. m. showed an average moisture content of 5.5 percent. Stick moistures at Bethera Tower were recorded as 7.0 percent at 12 noon and 5.5 percent at 5 p. m. Such close agreement seldom occurs, and it is possible only under very stable conditions. The sticks are intended to reflect changes in moisture content in the same degree as the litter but not necessarily the actual moisture content.

The fact that the behavior of each set of sticks almost always follows the group pattern is not merely a matter of chance. Basswood slat stock is purchased as free of defects as possible. Careful sorting upon receipt removes any other defective pieces which might not behave satisfactorily. These carefully sorted sticks are later exposed in the open until they lose 5 percent of their original weight. That step is necessary to overcome the initial period of rapid weathering. Later losses in service are small and can be offset by adjusting the dry weight of the set. Thereafter, the slats are oven-dried and grouped into sets of approximately uniform weights. Following that, the sets are tested at two prescribed temperature and relative humidity levels; whereupon all sets which show a departure of more than ±0.4 percent from the average are discarded.

Fuel moisture indicator sticks are not infallible, but the variation between sets should not exceed ±0.4 percent. The scale is accurate within ±0.25 percent at low moisture contents, and the weathering correction should offset weight losses within ±0.5 percent. Any

TABLE 1.—*Comparison of actual and estimated stick moisture content at various stations in West Virginia, Apr. 19–26, 1948*

Date	Time	Station	Relative humidity	Temperature	Wind velocity	Actual moisture content	Estimated moisture content
1948			*Percent*	°*F.*	*M.p.h.*	*Percent*	*Percent*
Apr. 19	11 a. m.	Huttonsville	19	78	0	5.2	5.2
Apr. 20	10 a. m.	Beaverlick	14	84	0	4.6	4.5
Apr. 20	3 p. m.	Neola	18	80	4	6.3	4.9
Apr. 21	11 a. m.	Sharp Knob	57	50	10.5	23.5	10.6
Apr. 21	4 p. m.	Cranberry	60	50	4	12.0	10.8
Apr. 22	1 p. m.	Mikes Knob	15	77	4	5.8	5.1
Apr. 23	11 a. m.	Bee Mountain	15	90	(1)	4.8	3.9
Apr. 23	4 p. m.	Kendalia	21	75	0	5.3	5.6
Apr. 24	10 a. m.	Buck Knob	24	87	0	4.5	4.5
Apr. 24	3 p. m.	Blair Mountain	12	96	(1)	3.6	3.4
Apr. 26	12 m.	Mingo Mountain	11	100	5	3.2	3.0
Apr. 26	5 p. m.	Tick Ridge	15	90	(2)	4.2	3.9

[1] Varying from 0 to 2.0.
[2] Varying from 0 to 1.5.

errors in excess of those amounts are usually due to improper handling or weighing.

All in all, checks in West Virginia, New Hampshire, Virginia, and South Carolina show that if care and precision are used in fuel moisture measurements, the record of individual sets of sticks compares significantly with the group average.

A Gee Whiz on Fire Line Construction.—The Gee Whiz, a horse-drawn spring tooth cultivator, has been used by farmers in the South for many years for working new ground. A few farmers have used it as a tool for fire line construction. About 1938 the Forest Service hired Louis H. Nowland, one of these farmers, as a lookout. He repeatedly asked why the Gee Whiz was not used on fires by the Forest Service but we stuck to the conventional Council tool and ax.

In March 1947 Mr. Nowland again brought up the subject during a fire inspection. The inspectors visited a farm where the farmer had built a Gee Whiz on a Roto-tiller garden tractor. It looked good, so the ranger was authorized to purchase one for experiment. A five-tooth Gee Whiz was purchased for $11. Several trial runs were made, with the ranger's pick-up for power. The pick-up had an extra low gear so it would travel slow enough for a man to walk behind it and guide the cultivator. These trial runs built some very good fire lines.

During these trial runs we found that the device worked best with the teeth set so that they turned the debris all in one direction. Also, when being operated by an inexperienced man, about 20 pounds of extra weight should be added to the Gee Whiz (to supply this weight a large stone was placed in the fork of the handles). The Gee Whiz showed up so well in the trials that we purchased two more. One of these has been placed with a warden tool cache and the warden has signed a rental agreement to use his mule and the Gee Whiz on fire suppression.

On March 11, 1948, the lookouts reported a large fire at 5 p. m. This was our first chance to use the Gee Whiz on actual line construction. The fire was coming up a steep slope to a long narrow ridge. Pine needles were 4 to 6 inches deep on the ridge. We took the pick-up as far down the ridge as we could and fastened the Gee Whiz to the back with a short piece of chain and started out. Seven minutes later two men, a pick-up, and the Gee Whiz had built 15 chains of fire line. One other man had backfired most of the line. About 4 chains had to have the second trip made over it to completely clear the line. No line was lost. The line was about 16 inches wide and went down into mineral soil about 2 inches.

The experience gained on this fire showed quite plainly that a man cannot handle a Gee Whiz at more than 3 miles per hour for more than a very few chains, so if a pick-up is used for power, it should have a truck transmission with four forward speeds.

On March 25, State Ranger Leroy Taylor drove up to a fire of over 200 acres. He had two men with him. At a nearby farmhouse he enlisted the help of a man and a boy, and the farmer's mule and Gee Whiz. There was a large amount of black jack oak limbs on top of a heavy accumulation of oak leaves and pine needles. It was necessary to make three trips over each segment of line. The first trip cleared off the brush and part of the leaves. The second cleared the line about 16 inches wide and 2 inches into mineral soil. The third was deadheading ahead to the next segment. One man drove the mule, one guided the Gee Whiz. The third backfired the line and the remaining two held the line and patrolled it. In 2 hours they constructed 50 chains of fire line through fairly heavy going. Taylor estimates it would have taken the five men approximately 5 hours to construct a line through that same location with Council tools.

The results of our experimenting so far have proved that the Gee Whiz is a good, cheap, light fire tool if it can be gotten to a fire with some type of power to pull it that can get around in the woods. The use of a pick-up truck for power is limited to the very accessible locations. It is often hard to locate a mule or horse that is available to pull the Gee Whiz. We hope to be able to try a jeep in the near future. It should be able to go over all but the very roughest of the country and will have more than ample power to pull the cultivator.—DON L. GERRED, *District Ranger, Talladega National Forest.*

BRUSH GUARD AND TIE-ROD PROTECTOR FOR THE JEEP

SOLON HYDE
District Ranger, New York State Conservation Department

In the spring of 1946, the State of New York acquired its first jeep for use in forest fire control. It was felt that there would not be much advantage in having a jeep unless it could be used for transporting water, fire-fighting equipment, or supplies over terrain too rough or too steep to be negotiated by a conventional type of vehicle. Further, it was intended that this jeep would travel not only over rough steep going in open country, but when necessary, in brush or small saplings to the limit of its capacity to push through. To do this the jeep required protection. The result was the development of the brush guard and tie-rod protector shown in the accompanying illustrations.

Figure 1 gives a good general idea of the construction of the brush guard. This brush guard is made of two pieces of 3-inch channel iron, each piece being approximately 13 feet 3 inches in length. These pieces are joined together in front, where they are secured by 4 bolts to a **U**-shaped supporting brace, which is bolted to and projects

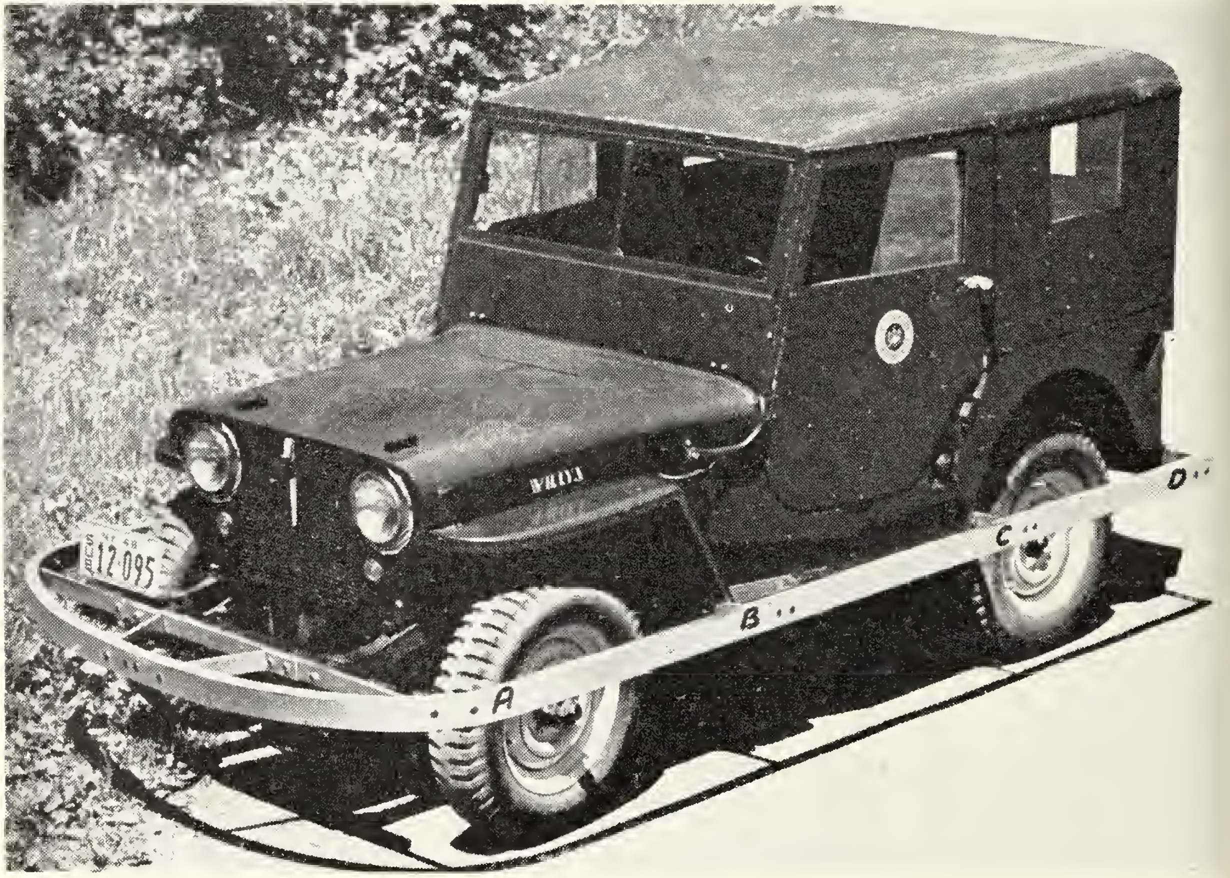


FIGURE 1.—Jeep of the New York State Conservation Department equipped with brush guard and tie-rod protector.

about 1 foot in front of the bumper. Other supporting braces are at points A, B, C, and D in the illustration. All braces except C are made of ½- by 2-inch iron. Brace C is made of ½- by 1½-inch iron, and goes through to the other side. It lies flat on the frame of the vehicle, is bolted to the top of the frame on each side, and then is twisted and shaped at each end to be bolted to the channel iron guard. Braces at points B and D do not extend through. Brace B is bent back and bolted to the side of the frame. Brace D is bolted straight to the rear of the frame.

Figure 2 shows the construction of the tie-rod protector from below. This consists of an iron plate 16 by 20 by ⅛ inches, reinforced by 3 heavier iron braces. The 2 outer braces are ½- by 1½-inch iron, the middle brace ⅜- by 2½-inch iron. The front of this assembly is bolted to the bottom of the jeep bumper, and the rear to the supporting brace which bends upward on each end to be bolted to the frame of the car. This rear support is made of ½- by 1½-inch iron.

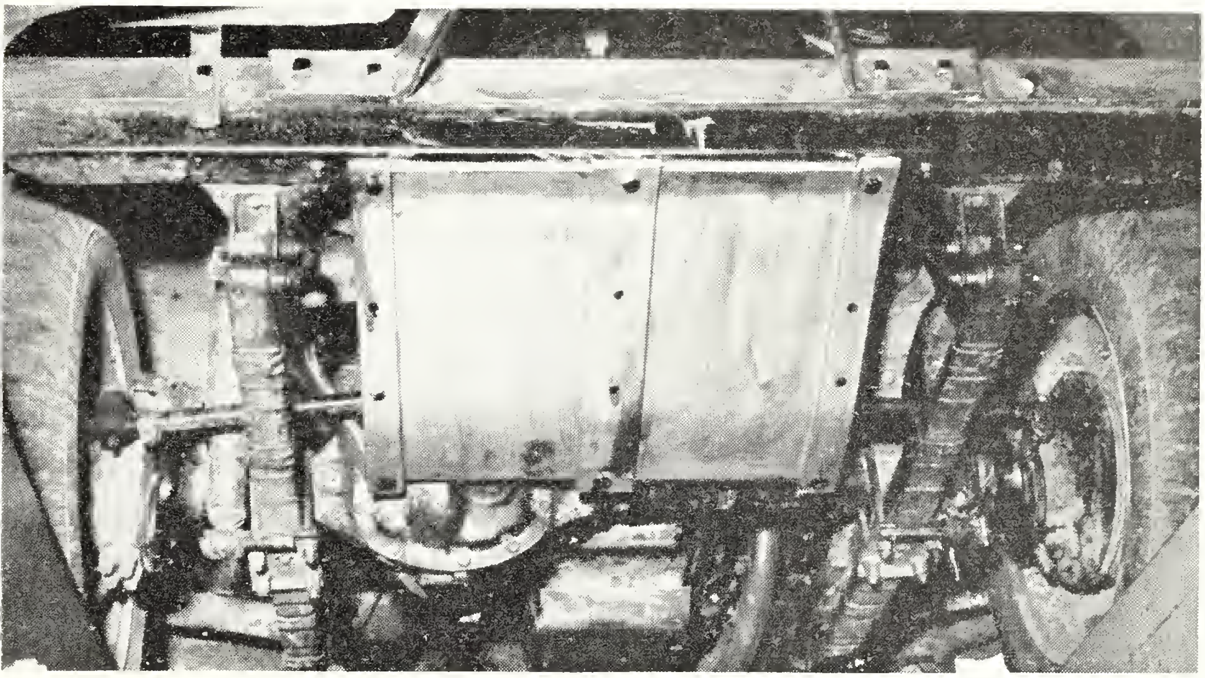


Figure 2.—Tie-rod protector from below.

It will be noted that no dimensions other than sizes of iron used in construction have been given. The only important dimension is the complete over-all outside width of the brush guard. While it is desirable that this be as narrow as possible, it must be wide enough to permit maximum turning of the front wheels, and also to permit the removal of a wheel to change a tire. It was found that 70 inches over-all width, with 3-inch channel iron for the guard, was about the minimum. This width is about 2 inches wider than necessary to permit the full cramping of the wheels, but it is necessary for the use of tire chains on the front wheels and to permit the removal of any wheel. However, using an over-all dimension of 70 inches does not permit the removal of a wheel unless the vehicle is jacked up with a bumper jack applied to the brush guard, thus letting the wheel sag sufficiently so that it may be readily removed. The necessary clearance between the inside of the brush guard and the front tire is 6 inches.

No cost data are available on the construction of these protective features. The need for the devices was recognized. One of the rangers, who is also a good blacksmith, was assigned to the job, and with the help of a couple of other rangers produced the results on our first jeep in a matter of 3 days. The material used on the first one was on hand. No drawings other than rough sketches were made and there were no calculations regarding stress and strain. The idea was "Be sure it is strong enough." No holes that might weaken the frame had to be drilled. In most cases it was possible to attach supporting braces to existing holes in the frame.

The first jeep so modified was subjected to rigid tests, and the protective guards stood up. Three more jeeps have been equipped in the same manner. The vehicle illustrated recently delivered water on a fire where one would think that only a crawler type tractor could go without suffering major damage. Lacking these protective devices, the jeep would never have been considered by the ranger for driving to the site of this fire.

Equipment Service in the Region 5 Emergency Fire Plan.—In Region 5 the servicing of equipment is conducted on a centralized basis. The Region is broken down into three areas. Each area has a central equipment depot and repair shop, with a branch shop on most forests. A superintendent has charge of equipment assignments in the area as well as the general overseeing of repair shops.

In addition to carrying on the various duties incident to equipment repair, the Equipment Service is geared to the emergency fire organization through the fire zone dispatcher who requests services when a forest is unable to handle the job with personnel and equipment already assigned.

In general, depot overhead, mechanics, truck drivers, and such clerical help as may fit into the fire organization are split into two teams. One team is on call 24 hours per day for 7 days, at the end of which period the second crew takes over on an uncalled basis. This gives a crew of overhead with a properly selected working crew to start required action upon call from the zone dispatcher.

In addition to the stand-by personnel, certain equipment is kept on hand at the central equipment depot. A typical roster of stand-by equipment would be as follows: 2 transport trucks, 2 D–7 tractor trailbuilders, 1 convoy luber, 1 fuel truck, and 4 stakesides.

In the stand-by crew are usually a tractor mechanic and a pumper mechanic who are available to accompany equipment to a fire. The on-call crew mans the transport truck, convoy luber, and fuel truck. The stakeside trucks and tractors are usually manned by zone personnel.

The off-call crew will, in most cases, be available immediately on call or within 1 to 3 hours after they are contacted unless permission has been granted to be out of contact for a longer period.

In the forest branch shops, the shop foreman cooperates with the forest fire control officer or dispatcher in setting up the fire organization. On large fires, the forest shop foreman is usually instructed to report to the fire camp to take over equipment repair and servicing for the transportation officer. Mechanics and helpers furnished from either the depot or other sources are usually placed under his jurisdiction.

In the foregoing capacity, the Equipment Service personnel relieve the zone dispatcher of a considerable amount of work incident to placing equipment on large fires; also they act to obtain equipment from other areas and to provide rental equipment from outside sources in case the need of the area in question exceeds the equipment available. It is evident that the area superintendent must not only know sources of Forest Service equipment but also keep his fingers on possibilities of commercial rental equipment.—VERL JEFFREY, *Acting Equipment Engineer, Region 5, U. S. Forest Service.*

BROKEN HANDLE REMOVER FOR SINGLE AND DOUBLE BIT AX AND PULASKI

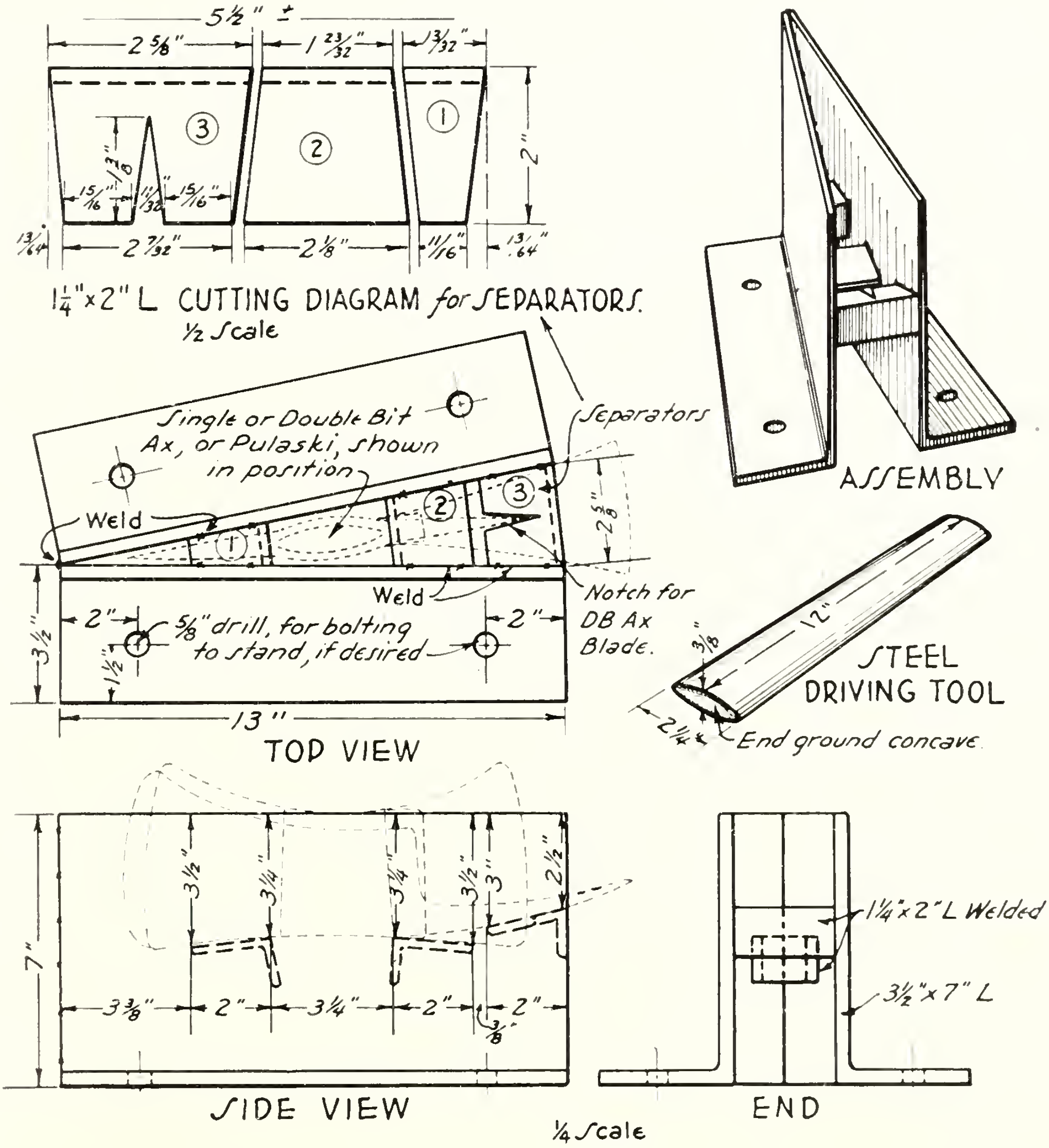
Division of Fire Control

Region 4, U. S. Forest Service

A safe and fast method for removing broken ax and Pulaski handles rom the tool heads has been developed by John Nasi and Tom Coski f the Payette National Forest and F. E. Powers of the Salmon National Forest. The idea originated in Region 1.

The broken handle remover consists of a holder, in which a head rom either a double or single bit ax or Pulaski may be placed, and a teel driving tool. To remove the broken handle saw off the handle ush with the ax head, then place head in holder and drive out the wood in the eye with the driving tool. Holes may be bored in the end f the eye wood to aid in removing stubborn wedges.

The remover can be made of hardwood bolted together; inside imensions should be the same.



EXPERIMENTAL TRIAL OF WETTING AGENTS

Division of Fire Control
Region 9, U. S. Forest Service

About a year ago five forests in Region 9 were furnished with small supplies of a wetting agent for experimental purposes. While only three of the forests have reported, and one of these has only tested the material on a brush pile fire, all were quite enthusiastic over the results obtained and the possibilities of a wetting agent for effective fire suppression. Excerpts are quoted from their reports.

Mark Twain National Forest, Mo.

"Solutions were used in back-pack pumps by fire fighters on approximately 20 fires during the recent fire season. Their observations are as follows: Both 1-percent and 2-percent solutions were more effective than water in all types of fuel.

"These solutions were found to be especially valuable in knocking down hot spots, extinguishing spot fires, and in checking spread until the line could be constructed. The solution seemed to go farther and to hold a fire in check much longer than water did. These were particularly important features on high danger days with strong shifting winds. The solutions had greater penetration than water, which made them very effective in deep leaf litter, our most common fuel. Probably because of its penetrating quality, the wet water will extinguish faster and hold a fire in check longer than plain water. This was noticeable in the heavier fuels such as oak slash and snags. In line construction, line holding, and in mop-up, the solutions were very definitely superior to water.

"The 2-percent solution seemed much more effective than the 1-percent solution. It is estimated that it compares in effectiveness with the 1-percent solution as the latter compares with water.

"Although several of the back-pack pumps held the solutions for weeks, there was no apparent corrosion of the galvanized lining. This, however, may not have been a sufficient test of the corrosive properties of the solution. If corrosion will not occur or can be prevented, it would be very desirable to use the 2-percent solution in the pumper units."

CHIPPEWA NATIONAL FOREST, MINN.

"It so happened that we did not have an opportunity to use the solution on an actual fire. However, one of our Rangers experimented with it in extinguishing a brush pile fire on a road clearing job this fall. The brush pile was burning well and one application of the solution resulted in complete extinguishing of the fire. It appeared to do a very good job of saturation.

"This forest also experimented with the use of other wetting agents. These were also found to be satisfactory, but were more difficult to mix."

LOWER MICHIGAN NATIONAL FOREST, MICH.

“The Mio District had an opportunity to give wet water a good ial on the McNeely, Class C, fire which occurred on Sunday August 7.

“This fire started in the middle of a large area of jack pine slash pro- uced a year ago. The fire danger at 9 a. m. was 21, at 1 p. m. the anger was 39. The fire started at about 11 : 30 and was reached shortly fter noon. The greater part of the suppression work took place near p. m. so it would be safe to say the fire danger during the suppression eriod was 39. There was an 11-mile wind at about 1 p. m. and at mes there seemed to be gusts of wind of higher velocity at the fire. had been 15 days since a rainfall of 0.01 inch had occurred. The umidity at 1 p. m. was 48 and at 5 p. m. was 46. The fire was held to 3 acres, of which practically all was slash covered. Individual trees ere observed to crown, but the crown fire never carried from tree to ee. The area had been cut over and there was only a light stand left hich probably helped prevent the crown spreading.

“The fire spread across full width furrows and we were unable to op it with only water in the back-pack pumps. After the fire would e knocked down it would seem to dry out and start up again. I then rought in our pumper and put the 10 gallons of wet water in the 200- allon tank, a rate of 1 gallon of wet water to 20 gallons of plain water. Ve used the pumper and hose on some piles of burning slash and on urning snags and stumps with very satisfactory results. We filled the ack-pack pumps with the wet water mixture and found that when the preading ground fires were extinguished with the wet water they tayed extinguished. By the time we got the wet water into action a rge number of volunteer fire fighters had been recruited or had eported without request so we had sufficient men to handle the avail- ble back packs with the wet water and we soon had the fire under omplete control.

“Considering the fuel conditions, the burning index, and the com- arison with the plain water we were all convinced that the use of the et water was well worth while and that we should secure additional upplies for future use and test. If we find that the wet water is not ny more corrosive than plain water, I would advocate having all of ur first run equipment supplied with it at all times.”

HUSKI GARDENER FIRE PLOW

R. F. Irwin

District Ranger, Trinity District, Davy Crockett National Forest

The Huski Gardener is a two-wheeled garden-type tractor with a Briggs-Stratton gasoline engine for power. It was first used in Texas by the Texas Forest Service, who developed the plow attachment with 12-inch rolling coulter and front brush guard. Two of these plows were secured by the U. S. Forest Service for experimental use in Texas, in October of 1947.

The following items have been added to the original Texas Forest Service plow: Brush guard over handle bars to protect operator; prestone solution in tires to increase weight; 6-volt battery and headlight for night work; 4-quart canteen in a rack; backfire drip torch; 4-pound double-bitted ax; fire rake; tool box containing Allen wrench, first-aid kit, snake-bite kit, pocket compass, map, notebook, pencil, and 4-cell electric head lamp. Cost of the Huski plow tractor was $300; the plow, coulter, and brush guard, $150; and the battery, headlight, and tool brackets, $25.

The Huski plow is 29 inches wide and will fit into a 48-inch pick-up bed, allowing a 17-inch tool box to be mounted on one side of the bed (fig. 1). The Huski plow unit consists of a pick-up truck loaded as

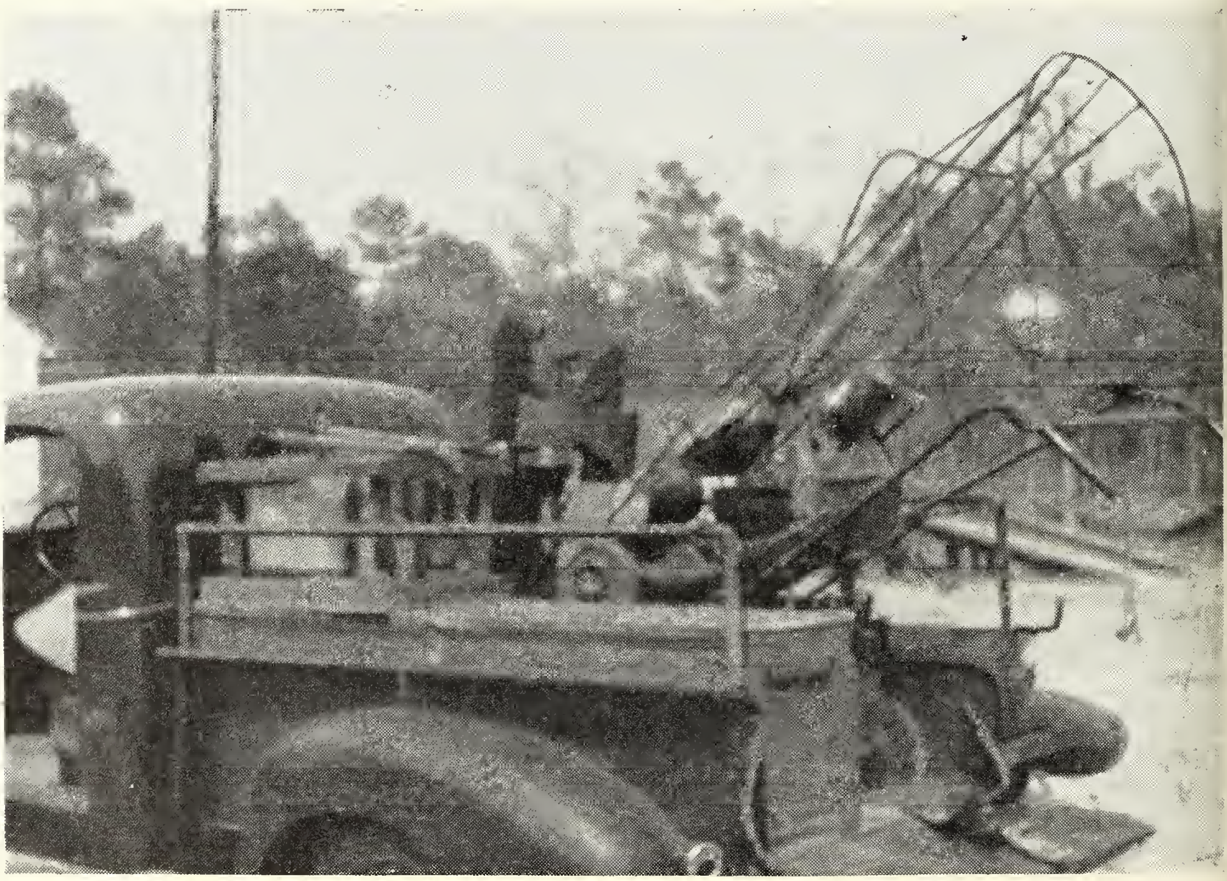


Figure 1.—Huski plow unit loaded on pick-up truck.

llows: The usual tool box carrying 4 fire rakes, 1 shovel, 1 double- tted ax, 1 4-quart canteen, 1 portable phone; a back-pump crate hich contains two 5-gallon back-pack pumps and two kerosene lan- rns; a 55-gallon drum of water with rotary pump for filling back ns; a sled for carrying the water drum, and the Huski plow. This ad weighs about 900 pounds.

A significant value of this unit is that two or three men making quick getaway to a fire can strike with the working equivalent of ven to ten men far sooner than such a force of hand-tool men can gathered and transported to a fire (table 1).

Some advantages of the Huski plow unit are as follows: Plow is ght and flexible. It can be transported any place a pick-up can go. he plow can be walked across country at a rate of 1½ miles per hour, d it will plow a line 18 inches wide at a rate of 40 to 80 chains per ur in shortleaf-loblolly pine type with moderately dense under- ush. The motor is so geared that the wheels keep turning when the ow is "hung," and the motor is seldom choked from overloading. he plow will replace 5 to 8 men using fire rakes, depending upon nditions.

By means of a "wooddeck" loading ramp, the plow can be loaded om the storage shed in less than 5 minutes. This eliminates the ed for a stand-by pick-up truck. Cost of operation is almost negli- ble since one gallon of gasoline will operate the plow for 2 to 3 urs, and the motor requires only 1 half-pint of oil every 25 hours operation.

TABLE 1.—*Summary of the use of Huski plow on seven fires in flat country*

ire ass	Soil type condition	Ground cover	Number of men in crew	Chains of line per hour	Remarks
B	Dry, sandy	Sl-loblolly pine, medium underbrush.	5	96	Good line.
C	Very dry clay and some sandy loam.	Open pine, heavy grass.	5	30	Only fair line; dry clay soil difficult to plow. Gullies present.
C	Very dry, sandy	Sl-loblolly pine, dense underbrush.	2	30	Night, only fair line.
B	do	Sl-loblolly pine, light underbrush.	2	80	Very good line, held 30 chains in ½ hour with 2 men.
B	Damp bottom-land.	Bottom-land hardwood, no underbrush.	2	88	Night, good line.
B	Moist, sandy	Sl-loblolly pine, medium underbrush.	3	60	Good line.
B	do	do	2	50	Fair line, had to stop plow to backfire.

Some disadvantages of the plow unit are as follows: Plow must be operated by a man walking. In heavy underbrush this is strenuous work and wears out the operator very quickly. The tractor has a very delicate clutching system and has no reversing gear to back it up when the plow hangs. After installation of 6-volt battery and headlight, plow became somewhat top-heavy. An unskilled operator will have occasional upsets.

It has been determined by actual use that a skilled operator using the Huski fire plow, can build a good 18-inch fire line at the rate of 40 to 80 chains per hour in shortleaf-loblolly pine type, with moderate underbrush. The operator should be assisted by an axman in the lead to clear out logs, and a man with a fire rake behind the plow to clean out skips and "roll backs." There should be a fourth man for backfire, although, on the small fires either the rakeman or the axman can drop back to handle the backfire.

In conclusion, it is believed that the Huski plow is well worth the cost. Correction of clutch difficulties and training of two skilled operators to go with the plow to each fire should make it a very successful piece of fire control equipment. The plow is suitable, principally, for operation in light sandy soils of the shortleaf-loblolly pine type with moderately dense underbrush.

Use of SX Radio in Aircraft.—To obtain air to ground radio communication on the Los Padres National Forest by the use of regular U. S. Forest Service radio equipment the SX type portable two-way radio has been found to work satisfactorily. This equipment has been used during approximately 900 hours of flying on the forest with better than 95 percent of plane to ground calls completed. Calls averaged four per hour of flying. The equipment naturally does not compare with that designed for aircraft, but is practical, especially in the infrequently used contract ship.

Several types of antenna set-ups are possible. In most aircraft the regular antenna wire may be attached to either the tail or wing assembly and strung through the window of the plane directly to the radio. On some types (Beechcraft Bonanza) it may be necessary to attach a permanent L-shaped clip to the wing tip in order to have something to which to tie the antenna. Wire should be fairly taut to avoid whipping.

On the Stinson "Voyager" the standard aircraft antenna may be utilized by soldering a 6-inch piece of extension aerial to it and extending this wire through the zippered inspection slot above the pilot's head. A convenient length of wire then connects this to the radio. No adjustment of the radio has been found to be necessary to accommodate it to the plane antenna. The aircraft radio must be turned off before SX aerial is clipped on or the tubes of the SX will be blown out.

The radio is operated in any convenient location in the ship. Ear rubbers on the headset are required to exclude plane engine noise.

With some practice by the operator and cooperation from the pilot it is felt that no aerial observer should be without radio communication when any regular Forest Service crystal controlled portable radio set is available.

It must be taken into consideration that the SX radio was not primarily built for use as an aircraft receiver and hence is not as efficient as a commercial receiver, however until we can get a better piece of equipment the SX will be the only radio in use on the Los Padres aerial project this season.
WARREN E. BARNES, *Fire Control Officer, Los Padres National Forest.*

Ieeting A Fire Situation.—The fire boss has to consider many factors, ılyze and correlate them, and make his decisions in order to be assured of a cessful plan to control a fire. The failure to take into account any one of factors can easily mean the difference between catching the fire promptly l losing it. The need for prompt but sound decisions is all important due to rapidity with which fires can spread and cause damage. The fact that a est fire presents an emergency situation often results in the fire boss or his ff overlooking some of the factors.

'he following outline or check list was worked out at the advanced Regional e Strategy and Organization School to aid the trainees in making a complete l systematic plan for control of the fires presented in the course's big fire blems. It is the joint product of the instructors and fire men who attended training sessions. The outline resulted in better planning and it was agreed erally that the fire boss and his staff could make good use of such an outline en actually on a fire.

PROBLEM
- a. Fire facts (inventory)
  - 1. Behavior of fire:
    - (past)
    - (present) Time of day and year
    - (predicted)
  - 2. Weather
    - Wind:
      - (velocity)
      - (direction)
      - Times
    - Humidity
    - Fuel moisture
  - 3. Topography
    - Features—ridge, saddle, river, etc.
    - Slope
    - Barriers
    - Culture—roads, trails, firebreaks, etc.
  - 4. Cover
    - Type
    - Density
    - Continuity or changes
    - Values
    - Control accomplishments
- b. Facilities for fighting the fire (inventory)
  - 1. Manpower, overhead, equipment, tools
    - Kind
    - Quality
    - Quantity
  - 2. Production rate
  - 3. When available

ANALYSIS OF SITUATION
- Consider, correlate, and calculate elements applicable to the fire

P PLAN
- a. Line
  - 1. Strategy and broad tactics by individual sectors
  - 2. Alternate plans of control and conditions requiring their use
  - 3. Time action is to be completed—priority, sequence
  - 4. Assignment of overhead, manpower, tools, special equipment by sectors
  - 5. Reserve forces available
- b. Plans
  - 1. Information to be gathered and time required
  - 2. Records to maintain
  - 3. Assignment of personnel and facilities
- c. Service
  - 1. Services to be provided—quantity, location, and time
  - 2. Assignment of personnel and facilities

E EXECUTION
- a. Convert plan into action
  - 1. Brief personnel
  - 2. Dispatch personnel
  - 3. Provide follow-up supervision

R REVIEW AND REMEDY
- a. Check—each step from inventory to execution
- b. Inspect performance and accomplishments
- c. Modify plan promptly to meet changed conditions, errors, or omissions

)ne feature of the outline is that it has a catch word "PAPER" to make it ier to remember the main steps and their sequence in meeting a fire situation; or problem, A for analysis, P for plan, E for execution and R for review and ıedy. This is a patterned after a similar device used in many Air Corps ck lists.—George M. Gowen, *Forester, Region 5, U. S. Forest Service.*

PROBLEMS OF FIRE PROTECTION ON REFORESTED STRIP-MINED AREAS IN INDIANA

S. J. Hensler and J. H. Winchell
District Foresters, Indiana Division of Forestry

Foresters in Indiana are viewing with some concern the problems in fire protection on some 14,000 acres of stripped coal lands that have been or are being reforested. The Strip Mine Act of 1941 requires that strip coal mine operators revegetate all land stripped (fig. 1) since the enactment of the law. At the present rate of stripping more that 2,500 acres will be planted annually with trees (fig. 2). The chief difficulty is in the uncertainty of just how severe or mild the fire protection problems will become as the trees get older and complete timber cover is accomplished. At the present time the problem of fire protection in these lands is not significant of anything that might happen in the future. There are no cases on record where a fire has swept over spoil lands to destroy a natural cover or a plantation of young trees. Fuel conditions conducive to burning are in general lacking on most stripped areas. Even the older plantations 15 to 20 years in age do not have as yet an accumulation of duff which might be considered a severe hazard. Just what will happen when these plantations, which are principally pine, advance in age and leaf litter and dead branches accumulate remains to be seen.

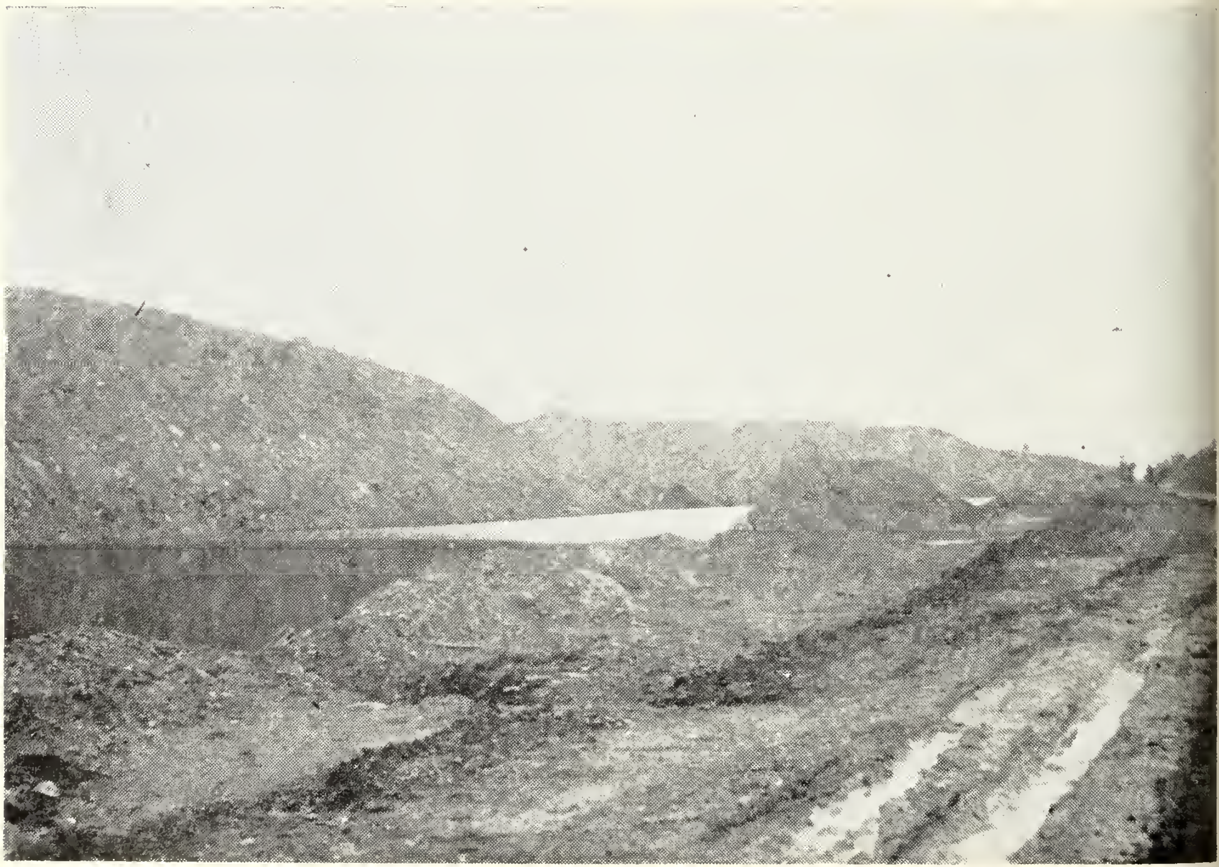


Figure 1.—Stripped area before planting. Note the long, narrow lake.

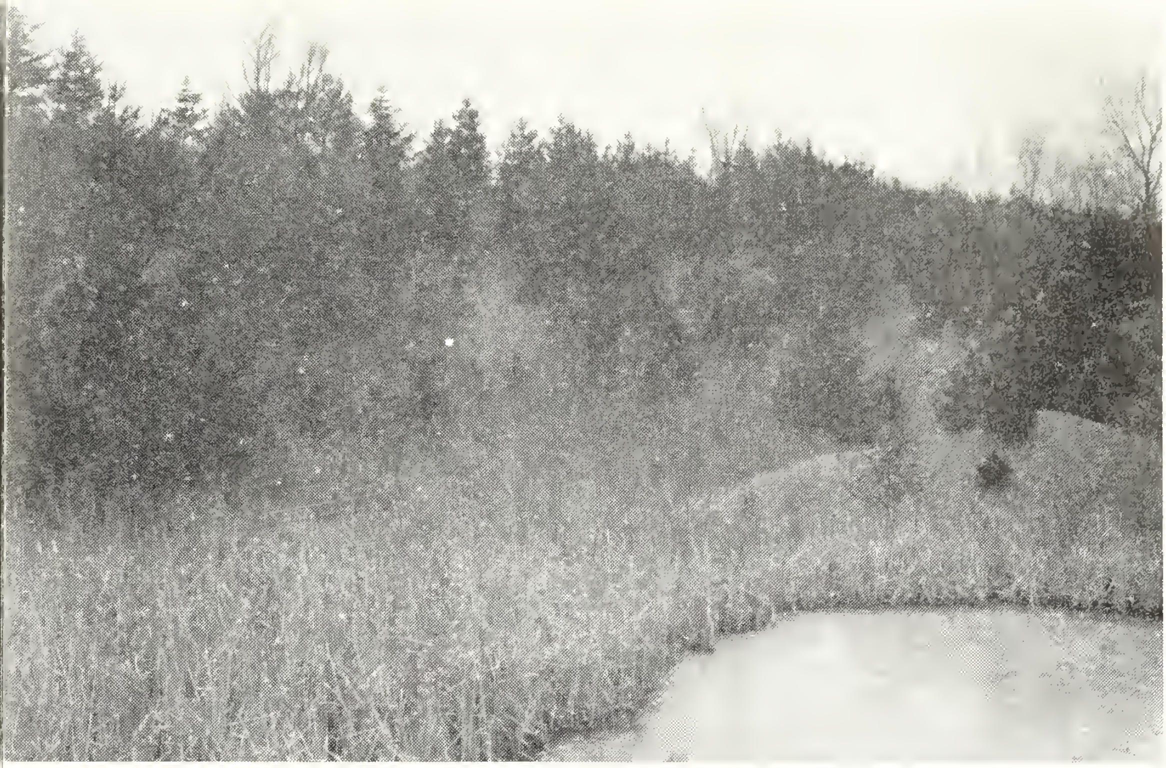


Figure 2.—A typical young pine planting on a strip-mined area.

The stripped lands from a fire protection standpoint have several ctors in their favor. Most areas have long narrow lakes sometimes nile or more in length which will act as natural fire barriers. Deep x cuts in many cases separate the stripped areas from adjacent flat nds and will act as fire barriers. Old haulage roads will act as bar- rs also and provide, to some extent, access to the areas. Another ctor which from the surface is not readily apparent but has been finitely established is that soil moisture conditions are higher in the ip bank than on adjacent unstripped areas. This might indicate at fuel moisture conditions will also be high.

On the other hand there are several factors which can add to the fficulties of fire protection.

As already mentioned the reforestation of stripped lands has been gely with pine species. These of course constitute a more vere fire hazard than hardwood species. Most areas will offer little couragement toward the use of any mechanized fire equipment as e terrain in most cases is forbidding. Unless access roads or fire es are constructed the fire fighting will be limited to the use of nd tools.

The area of the stripped lands does not come under the surveillance the present tower detection system and this along with access roads d fire lines will have to be planned.

Present trends point toward heavy use of stripped lands for recrea- nal purposes. Many lakes on these lands are already intensively ed for fishing and boating. Many areas offer attractive sites for bins and will no doubt be more fully developed for this purpose the future.

With a heavy influx of recreationists during periods of high fire nger the problems of fire protection will no doubt increase.

The State Division of Forestry feels that any problems in fire pro- ction which are peculiar to these areas will be solved with the excel- nt cooperation of the coal operators.

VEGETATION TEMPERATURE AND FIRE DAMAGE IN THE SOUTHERN PINES

George M. Byram
Physicist, Fire Research, Southeastern Forest Experiment Station

It has long been known that pine stands in the South are more severely damaged by late spring or summer fires than by winter fires. The usual explanation is that a stand is most susceptible to fire injury during the growing season, or that dormant trees during the winter season are least susceptible. It is also thought that summer fires are hotter than winter fires.

Summer fires probably do have a somewhat higher intensity than winter fires. It is also likely that pines may be slightly more susceptible to injury during certain periods of the growing season. However, a theoretical analysis of the factors contributing to fire damage has shown that other factors may be considerably more important than the two just mentioned. The details of the analysis are outside the scope of this discussion, which will concern the results of the analysis rather than the technical aspects of its development.

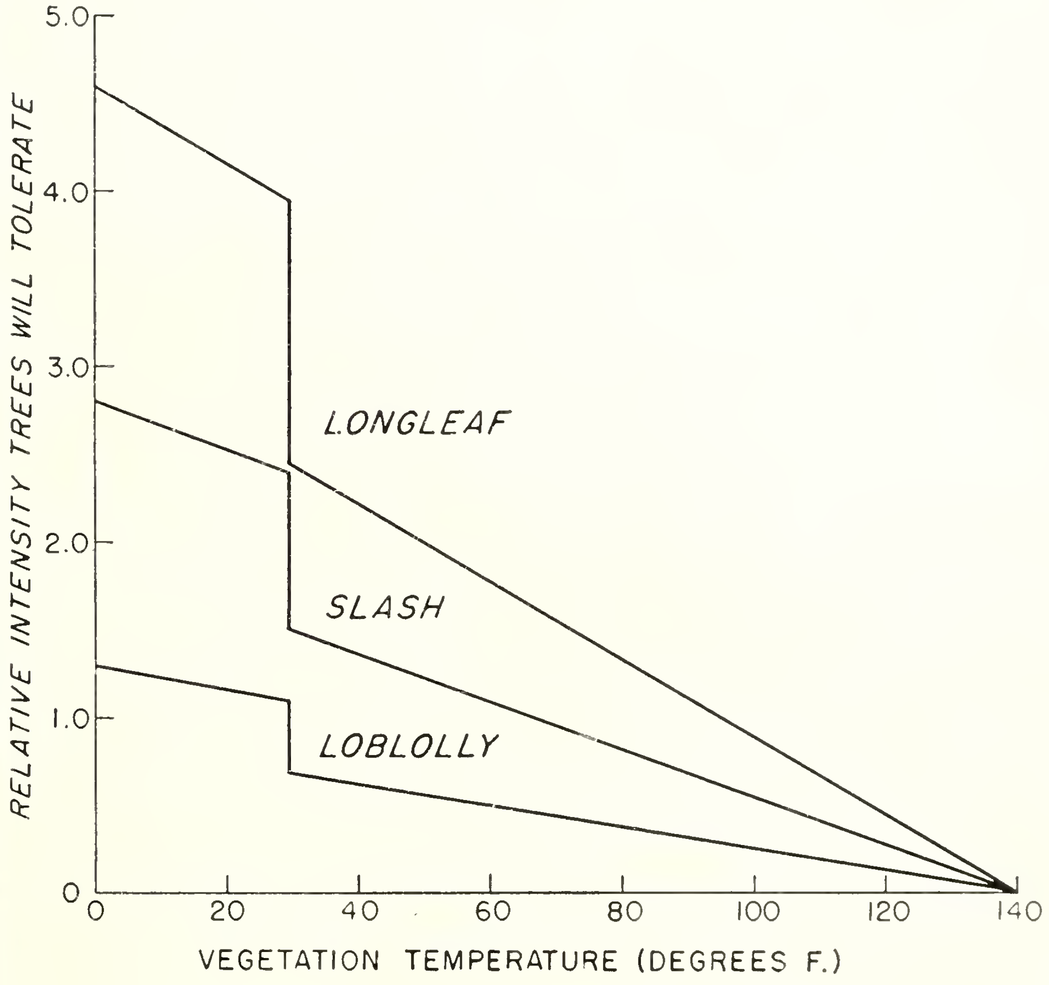
The lethal temperature for plant tissue is in the neighborhood of 140° F. It may be assumed that the buds, needles, and branch endings of a pine will die if heated to a temperature exceeding 140°. An analysis of the lethal effects of fire, therefore, reduces to an analysis of those factors which directly or indirectly affect the temperature of the susceptible parts of a tree. Of these, the initial vegetation temperature may be one of the most important. The temperature of the foliage of a pine in bright sunlight may exceed 105°. Therefore, an increase of only 35° would be required to reach the lethal temperature, and the absorption of a relatively small amount of heat by the foliage would accomplish this. On the other hand, the foliage temperature might be only 35° or 40° during a cold period in winter. Under these conditions considerable heat would be required to raise the temperature up to the lethal value of 140°. A fairly intense fire during cold winter weather might therefore do no more damage than a low intensity fire in hot summer weather. The same comparison might be made between hot and cold spells both occurring in the winter, or both occurring in the spring.

Theoretical curves in figure 1 show the relative fire intensities that longleaf, slash, and loblolly pine should tolerate at different temperatures. At a temperature just above freezing, any one of these pines should tolerate a fire more than twice as intense as it would on a warm day when the vegetation temperature is 95°. One of the most noticeable features about the curves is the sudden increase in a pine's heat tolerance at temperatures below 29°. At this temperature, since most of the water in the needles and buds would be frozen, large quantities

heat would be required to convert the ice back to water. At a tem-
ature of 29° pine foliage should tolerate a fire about four times
intense as at a temperature of 95°. Some field men have noticed
t cold weather fires have resulted in much less damage than might
expected.

urves for hardwoods should be very similar to those for pine, except
t their heat tolerance would be lower. In stands managed for the
petuation of pine, hardwood sprouts could probably be girdled
st effectively by burning in hot, sunny weather.

nother important factor associated with temperature changes in
crown of a tree concern the morphological characteristics or
ometry" of the needles, buds, and branch endings. The rate of tem-
ature rise in these susceptible parts is inversely proportional to
ir size. When they are massive and heavy, they will not reach as
h a temperature as when they are thin and light. This may explain
y suppressed trees, the susceptible parts of which are dwarfed and
small volume, are more easily killed by fire than vigorous trees of
same size. It may also explain why longleaf pine is less suscepti-
to fire than other species of pine. Also the terminal buds of long-



ure 1.—The theoretical relation between vegetation temperature and a tree's
at tolerance. Heights of these curves represent the relative fire intensity
at slash, longleaf, and loblolly pine will tolerate at different vegetation
mperatures. The three species of trees are assumed to be of the same size

leaf are surrounded by a protecting sheaf of needles which retards a temperature rise in the bud.

The following tabulation shows the diameter in centimeters of the terminal buds on longleaf, slash, and loblolly pine. Susceptibility ratings are given in the third column. These ratings are found by taking the reciprocals of the values in the bud-diameter column.

Species:	*Bud diameter*	*Fire Susceptibility*
Longleaf pine	1.16	0.86
Slash pine	.72	1.39
Loblolly pine	.33	3.00

The relative positions of the three curves in figure 1 were determined by the diameters of the terminal buds in the three species.

Wind is another important factor affecting the temperature of vegetation exposed to radiant heat. Wind has a conductive cooling action on buds and needles, which reduces the rate of temperature rise. Men who have done much work with prescribed burning usually consider wind the most important factor in the amount of scorch they are likely to get. Unlike temperature, many of the effects of wind can be readily observed. A sudden shift in the wind can convert a low intensity backfire into a high intensity headfire in a few minutes' time.

Some of the effects of wind are not yet well understood. It is known that scorching is severe when a fire burns in calm air. In this case, lack of turbulence permits the hot gases to pass straight upward in a more or less streamline flow. However, recent thermocouple measurements indicate that there may be additional reasons for the scorching in calm air. When a line of fire passes under a tree, the foliage is subjected to two peaks of intensity. One peak is the result of radiant energy from the approaching fireline; the other is caused by convective heat from the burning gases. For a backfire the peak for radiant heat comes first, and for a headfire the peaks occur in reverse order. In calm air they occur simultaneously.

It is difficult to compare the relative importance of wind and temperature because their effects are interrelated. In a headfire, wind increases the fire intensity by speeding up the combustion process. This is partially offset by turbulence which retards the upward flow of heat. In addition, wind exerts a conductive cooling effect on buds and needles.

Basic studies are now in progress on the Francis Marion National Forest to obtain experimental checks on the results of the theoretical work discussed in this paper. In addition, these studies should yield information for determining the proper place of fire in the management and protection of loblolly pine. This information should also be applicable in large part to other species of pine such as slash, longleaf, and possibly even shortleaf.

igher Helicopters Limits.—The value of the helicopter in fire suppression
vities is no longer questioned. Anyone who read Frank Jefferson's excellent
cle on the subject in the January 1948 issue of Fire Control Notes should need
urther convincing that rotary-wing aircraft has long since passed the experi-
tal stage in this field. But helicopter operations have always been hampered
he low hovering ceiling of the aircraft. Forest Service reports in 1945 stated
a helicopter then being tested (Sikorsky R-5A) lacked the ability to carry
necessary pay load in spot landings and take-offs at elevations over 3,000 feet
summer temperatures. Two years later, California foresters used improved
lels at elevations up to 5,400 feet under similar conditions. But this is still
sufficiently high in the Rocky Mountain Region, where in most places an
ation of 5,400 above sea level only means an impressively deep hole in the
ınd.

was, therefore, with considerable consternation that we learned that the
ver branch of the U. S. Geological Survey had chartered a helicopter to
isport surveyors in triangulation work on a mapping job near Canon City,
., last winter. It was intended that the machine should transport surveyors
their equipment, one at a time, from the airport to adjacent triangulation
its. Since the elevation of the Canon City airport is a prohibitive 5,500 feet,
project seemed a shade on the doubtful side; but the Geological Survey report,
ions of which are given below, speaks for itself:

'he helicopter operation was accomplished in 10 man-days. The same tri-
ılation work, under summer conditions and by automobile and foot travel
ld have taken an estimated 36 man-days.

Vind velocity for these operations varied from zero to an estimated 40
. h. One take-off was accomplished from 9,300 feet above sea level with a
n. p. h. wind; and one at 10,200 feet in zero wind. The temperature varied
4° to 48° F., with most flights being made while the temperature was above
All high altitude landings and take-offs were made under favorable con-
ons, but it was eventually decided to forego any more landings at extreme
ations due to the fact that the weather and wind conditions were not suffi-
tly stable at this time of the year to provide the necessary margin of safety
ired at maximum altitudes.

)uring the second day of the operation, Mark Rousseau was transported to a
ntain peak at an elevation of considerably over 10,000 feet above sea level.
erected a triangulation signal and was returned to the airport by the heli-
er; but after discussions with the pilot, it was decided not to attempt to
py this point as he stated that every bit of power was required to make the
-off from this point and it would be unsafe to make repeated flights to points
ıat elevation.

ll triangulation point landings were normal hovering landings. All take-offs
normal hovering or 'jump' take-offs."

ıere is no doubt but that unusually favorable temperature and air density
litions enabled successful helicopter operations at such elevations and
the aircraft was being skillfully piloted near its uppermost limits, but
machine itself deserves considerable credit. It was a Bell 47D, currently
latest thing in commercial helicopters. Some of its specifications follow:

Seating capacity	1 passenger and 1 pilot
Engine	Franklin, 178 h. p.
Cruising speed	92 m. p. h.
Speed range	0 to 100 m. p. h.
Gas capacity	33 gal.
Gas consumption	12 gal. per hr.
Rotor blades	Matched woods with stainless steel leading edge and steel core
Main rotor diameter	35 ft.
Blade tip speed	400 m. p. h.

is account is not a plea for pushing our existing rotary-wing aircraft
nd their safe operating limits, but is rather an indication that further
pment development may before many more fire seasons make timber-line
opter operations a normal procedure. Distinct hope for this is held out
final quote from the Geological Survey report:

Representatives from the Bell Aircraft Corporation have advised us that
have a machine now undergoing tests that will have a service ceiling of
)0 feet above sea level, and that should be able to make hovering landings
take-offs anywhere in the Rocky Mountain area."—Wilfred S. Davis,
ster, *Region 2, U. S. Forest Service.*

SMOKE JUMPING IN THE SOUTHWEST

F. L. Jackson

District Ranger, Gila National Forest

The year 1947 started a new era of fire fighting methods in the forests of the Southwest. This was the first year the aircraft and smoke jumpers were used to suppress forest fires.

The crew of men selected and assigned to Region 3 for a trial run (fig. 1), arrived on the scene on May 23. A day or two of preparation ensued, and was followed by an actual fire call a few days later. This was the initial fire for the smoke jumpers in Region 3.

Since that time it has been demonstrated that the use of smoke jumpers is practical to reduce burned acreage in the forests of Region 3. Adaptations will have to be worked out for each forest, based on the experience gained on other forests. The 1948 project now in progress is already developing many changes and should be continued if smoke-jumper activity is expanded to other forests in the Region.

Under the present set-up on the Gila Forest, a single engine Noorduyn (C–64) is used. This ship was modified for jumper use and for dropping cargo before it came to the Region. One pilot is assigned to fly it, and to care for all maintenance as required. So far this type of plane has been found to be well adapted to conditions here in the Southwest and has given excellent service. The plane and pilot were assigned from Region 6.

Under normal operating conditions, the plane carries the pilot, a spotter (or cargo dropper), two to four jumpers, and their fire packs. The jumpers, foreman, and leader were trained and assigned from Region 1. All are well qualified to handle the suppression job.

The load the plane can carry depends upon the weather conditions and time of day. This factor is carefully weighed against the urgency of the call for the jumpers or cargo. The safety factor is given full consideration. For example, under favorable conditions the plane would carry a safe load of two thousand pounds, when later in the day during the summer months, as the temperature increases, this loading capacity is reduced to around one thousand pounds. In addition, considerable air turbulence is encountered in flight to the forest area, and unpredictable downdrafts make close flying hazardous over mountain areas. The pilot is required to fly at a low altitude over the fire or drop spot to safely release the men or cargo.

Fire detection on the Gila Forest is handled by the regular detection force on the ground. No patrol work is done, except on request while the plane is in flight. Radio contact is maintained between the plane and the ground by means of the regular plane radio and an SPF set on one of the main lookouts. Secondary contacts are maintained with SPF sets at ranger stations en route. So far this arrangement is satisfactory but it is believed could be improved upon by better location of the SPF sets.

When a fire call is received by the smoke-jumper dispatcher the crew and pilot function as one operating unit. The spotter assigned to the jump crew for the day acts as leader. The dispatcher and the

FIGURE 1.—Smoke jumpers, pilot, and plane assigned to Region 3.

ot plot the best course to the fire from the readings given and pin
nt the fire location on the maps to be used by the pilot, spotter, and
npers. A copy of the fire call request is carried by the pilot and
jumpers in the event further information is needed after they
ve the ground. The spotter organizes his crew according to the
uest. The men are suited up on the ground, parachutes checked,
nbers recorded, etc., and the pilot and spotter briefed by the dis-
cher before take-off. Jumpers are instructed as to the best way
from the fire and when and where relief by ground crews can
expected. Usually the jumpers reach the fires before the ground
ws though both receive their fire calls at the same time. Here is
element of competition that cannot be overlooked, especially if sup-
ssion by air crews can reach fires before ground crews, keep the
s small, and reduce the total cost of suppression and damage. On
remote areas of the Gila Wilderness Area fire suppression from
air has proved its worth judging from the records of the past
ars.

he usual get-away time for the plane and crew is less than 10
utes. This requires needed preparation, servicing of the plane,
a coordination of all hands toward the one important objective,
ing on the fire as soon as possible. Usually fire packs consisting
huck, beds, tools, water, etc. are prepared for two men and pack-
d so that it can be sent down with one chute. The minimum num-
of men on one jump is two men, unless fire conditions warrant more,
ther emergency exists.

o far in 1948 the crew has made 33 jumps. Four fires were handled
out follow-up assistance from ground men. Food and supplies
e dropped to a Coronado fire of 2,500 acres, to eliminate a difficult
k string job. Some of these fires would, no doubt, have attained
e proportions had they not been reached in time, and would have
a large amount to control.

A NEW FIRE DANGER METER CARD

James R. Crowell
Dispatcher, Talladega National Forest

A simple method of using index numbers to determine fire danger on the Appalachian 100 Point Scale has been developed at the Talladega Ranger Station, Talladega, Alabama, by the writer. There are no wheels to turn, no slide rules, in fact no moving parts whatever, to wear out or to confuse the inexperienced. For example from the card illustrated below:

	Index No.
Days since ½" rain, cured stage: 4 and over	4
Wind rate: 7.5 to 12.5 m. p. h.	2
Fuel moisture: 4.0 to 12.5	4
Total	10

Now, under Fire Danger Class, index number 10 gives High IV (class day) and 45–55 (100 point reading).

FIRE DANGER METER (*Type 7*)

Days since one-half inch rain by fuel stages

Green		**Transition**		**Cured**	
Days	Index No.	Days	Index No.	Days	Index No.
0–3	0	0–3	2	0–3	3
4–8	1	4–8	3	4 and over	4
9–15	2	9 and over	4		
16 and over	3				

WIND

Miles p. h.	Index No.
0–3.4	0
3.5–7.4	1
7.5–12.5	2
12.6–18.5	3
18.6–24.5	4
24.6 and over	5

FUEL MOISTURE

Weight	Index No.
25.1 and over	0
12.6–25.0	2
4.0–12.5	4
3.9 and less	5

FIRE DANGER CLASS

Index No.	Class day	100 point reading
1–4	I	0–10
5	Low II	11–15
6	High II	16–20
7	Low III	21–26
8	High III	27–33
9	Low IV	34–44
10	High IV	45–55
11 and 12	Low V	56–77
13 and 14	High V	78–100

To determine Fire Danger use sum of index numbers in Fuel Stage, Wind and Fuel Moisture columns as index number in Fire Danger Class column.

Iobile Telephone Service in Cooperative Forest Fire Area.—It is a well-wn fact that cooperation is the key to effective fire protection for certain tern watersheds. In these areas the protective organization is often one knit n the suppression forces of a number of cooperators, private as well as public. h organizations lean heavily on a reliable interagency communication system. ecently there has been introduced into the communication picture a vehicle io-telephone service developed by the Bell Telephone System. Subsidiaries of American Telephone and Telegraph Company are installing such units in the vier subscriber areas to furnish service to municipal power, water, policing, l fire protection organizations as well as private businesses having need for munication from mobile units to their central place of business. This vehicle io-telephone system bids well to become an important adjunct to a cooperative protection force which is activated through a central dispatcher such as the it Federal, private, and municipal organization developed under the Clarke- Nary Section 2 program for the Salt Lake Valley watershed in Utah.

ne of the principal advantages of using the equipment developed by the phone people is that it furnishes a common medium of communication that cooperators can afford to install. Many cooperators could not afford to invest roximately $1,200 per unit in mobile VHF-FM equipment, but can afford to up a small budget for seasonal rental of standard telephone equipment from ommercial concern that is devoting its entire program to furnishing the pub- the communication it demands. Then too, the company takes over responsi- ty for installation, repair, maintenance, and development. Maintenance alone n item of considerable expense when equipment is owned outright.

egardless of whether a cooperator owns his VHF-FM mobile equipment or ts it from a telephone company, there is an initial cost of preparing a motor icle to insure sufficient continuing power for a full fire season use. The costs uch installations are about as follows:

Generator, 35 amp. at 10 m. p. h.	$40
Power battery, 180 amp	20
Regulator	6
Installation of above	40
Total	106

or the Salt Lake City area the Mountain States Telephone & Telegraph Co. naking the following charges now for installation and rental. As more units installed these costs should go down.

t of initial installation	$25
ital of equipment per unit	15
nthly message guarantee allowing up to 40 minutes of calls per month	7

thing over 40 minutes at rate of 20 cents per 3 minutes.

dispatcher system is set up the $7 guarantee is reduced to $2.50 per unit, there is a $3 charge made for a dispatching terminal.

his development by the telephone people demands investigation, especially ere dollars are a big consideration in outfitting a diverse group of coopera- and where VHF-FM reception has sufficient coverage. In Region 4 of the est Service two areas where it is especially practical are the Salt Lake Valley tection area and the Reno-Carson area. In the Salt Lake area the cooperative tection force is activated through one common dispatcher. The following of major cooperators gives some idea of the scope of coverage and the need good interagency communication:

Salt Lake Water Department
Salt Lake Fire Department
Bountiful Fire Department
Farmington Fire Department
Salt Lake Parks
Salt Lake Police
State Traffic Forces
Salt Lake County Sheriff
State of Utah Highway Department
State Forester
Wasatch National Forest
Utah Power & Light Co.
Mountain States Telephone & Telegraph Co.

per correlation of all these organizations results in a communication load ch Forest Service facilities probably never would reach. But the vehicle io-telephone service reaches all mobile and fixed station installations of all perators.—J. W. Mattsson, *Forester, Fire Control Region 4, U. S. Forest vice.*

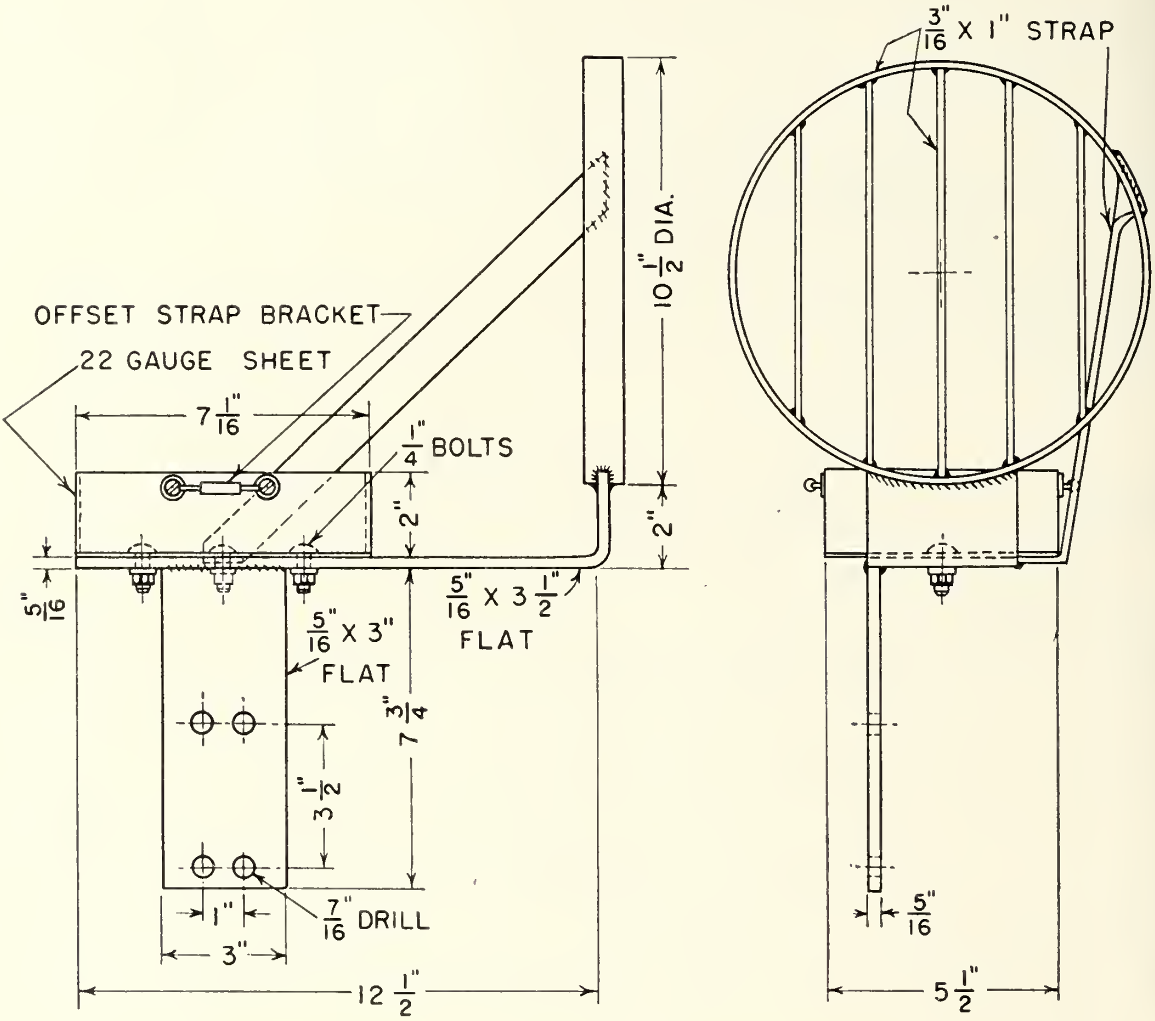
PORTABLE TRACTOR HEADLIGHTS

M. D. Stowell

Fire Control Officer, Plumas National Forest

For several years the need for an emergency set of tractor headlights that could be installed quickly and easily on logging tractors used on fires has handicapped our night control efforts.

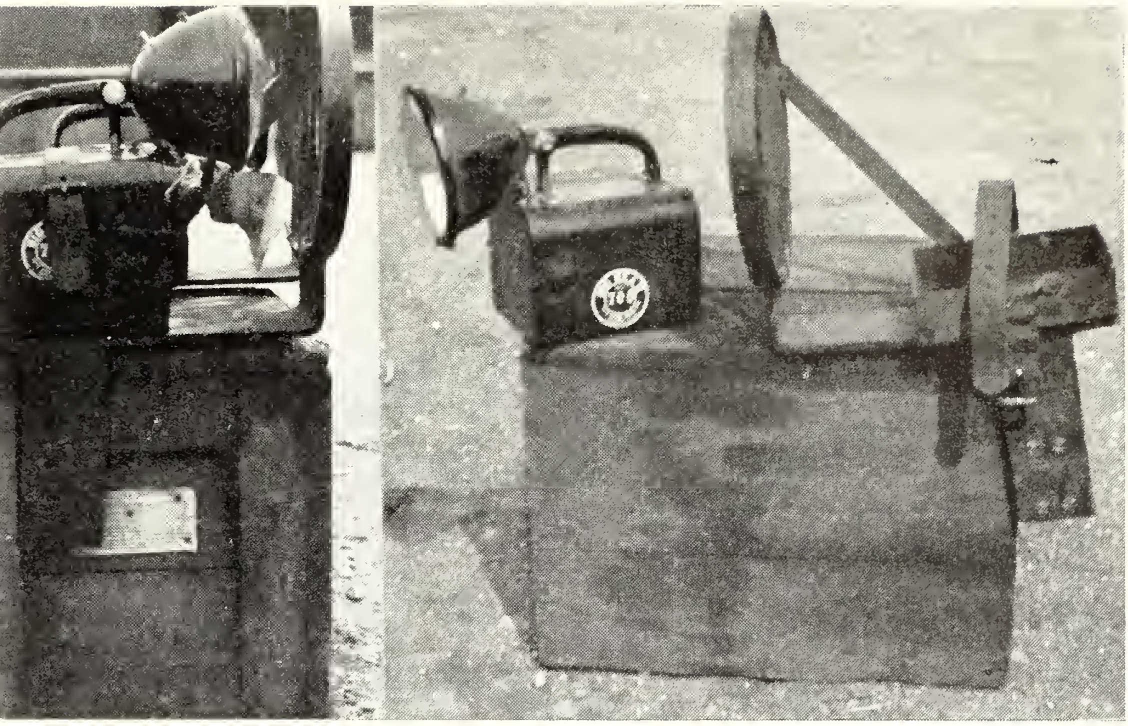
The U. C. Lite Manufacturing Co., Chicago, manufactures a portable light, Big Beam #700, that operates on 4 screwpost dry cell batteries. This light fills this need for a light weight readily portable headlight. A bracket to mount this light on tractors was designed by E. E. Kessler, Plumas welder and blacksmith (figs. 1 and 2). This



USE 1 1/2" LEATHER STRAP AND BUCKLE TO HOLD BIG BEAM LITE #700 IN PAN.
ALL CONNECTIONS OF STRAP IRON WELDED.
HOLES TO MOUNT BRACKET ARE DESIGNED TO FIT HEADLIGHT BRACKET HOLES ON ALL CATERPILLAR TRACTORS D-4 TO D-8.
USE 3/8" X 1 1/2" HEX. HEAD STANDARD THREAD STUD BOLTS TO ATTACH BRACKET.

DESIGNED: E.E. KESSLER & M.D. STOWELL
SKETCHED: M. D. STOWELL 5-4-48

Figure 1.—Bracket for portable battery tractor light.



URE 2.—Portable tractor headlight and bracket, assembled and separate.

ket can be quickly attached to any caterpillar tractor by merely
rting 4 stud bolts into the tapped holes in the radiator housing
gned to hold regular headlight brackets. Tests on fires proved
this light will operate for 6 to 8 hours continuously on one set
atteries. The cost of the light is approximately $18.25.
ne bracket can be readily made by any welder and can be installed
nyone. Spare batteries can be carried and quickly installed if
er use of the headlights is desired.

cket-Size Fire Control Plans.—The Rhode Island Forest Service has en-
ored to make the most and best use of its annual forest fire control plan.
nning with the spring of 1948, State Forester Jacobson, at the suggestion of
er Alton M. Markham (recently deceased), revamped the fire control plan
aking a pocket-sized edition. An inexpensive standard 6-ring, 4- by 6-inch
r has been used for cover protection of the loose-leaf plan. Each of the 35
forest fire wardens has been furnished a copy with his name on the cover.
booklet is labeled "Rhode Island Forest Service—Fire Control Plan." In
ion to the text, the most recent forest fire law publication is included.
e advantages of this unique project are at least three-fold:

Provides a fire control plan and directory of personnel which can be easily
ed in one's pocket.
Sections can be amended without making a complete run of the plan.
Fire wardens are given a boost in morale by having names printed on indi-
l covers.

yone interested may obtain more detailed information of the contents, costs,
he like by writing Mr. Eric G. Jacobson, Chief Forester, Office of Forests and
, 18 State House, Providence, R. I.—Edward Ritter, *Region 7, U. S. Forest
ce.*

DEMOUNTABLE TRANSPORT BED FOR 50-MAN FIRE UNIT

M. O. Adams
Central Dispatcher, Shasta National Forest

The device discussed here was prepared by the Shasta to obviate keeping a loaded truck on stand-by. This Shasta idea prompted the development of a standard slip-on bed for Region 5. Design and specifications should be available soon.

District Ranger L. L. Feight, Fire Control Assistant G. Call, and Prevention Aid K. Mason of the Pit Ranger District developed and put into use a loaded 50-man fire camp unit which has reduced loading time and can be handled by one man with a minimum of effort.

These men constructed a wood bed with stakes, similar to a standard stakeside, out of lumber salvaged from an abandoned sawmill. The complete unit is 11 feet, 7 inches in length, 6 feet, 5 inches in width, and 38 inches high. Six wheels salvaged from safes were mounted between the bed members to aid in loading and unloading. The finished bed has an unloaded weight of 400 pounds and when fully loaded a gross weight that does not exceed 3,000 pounds.

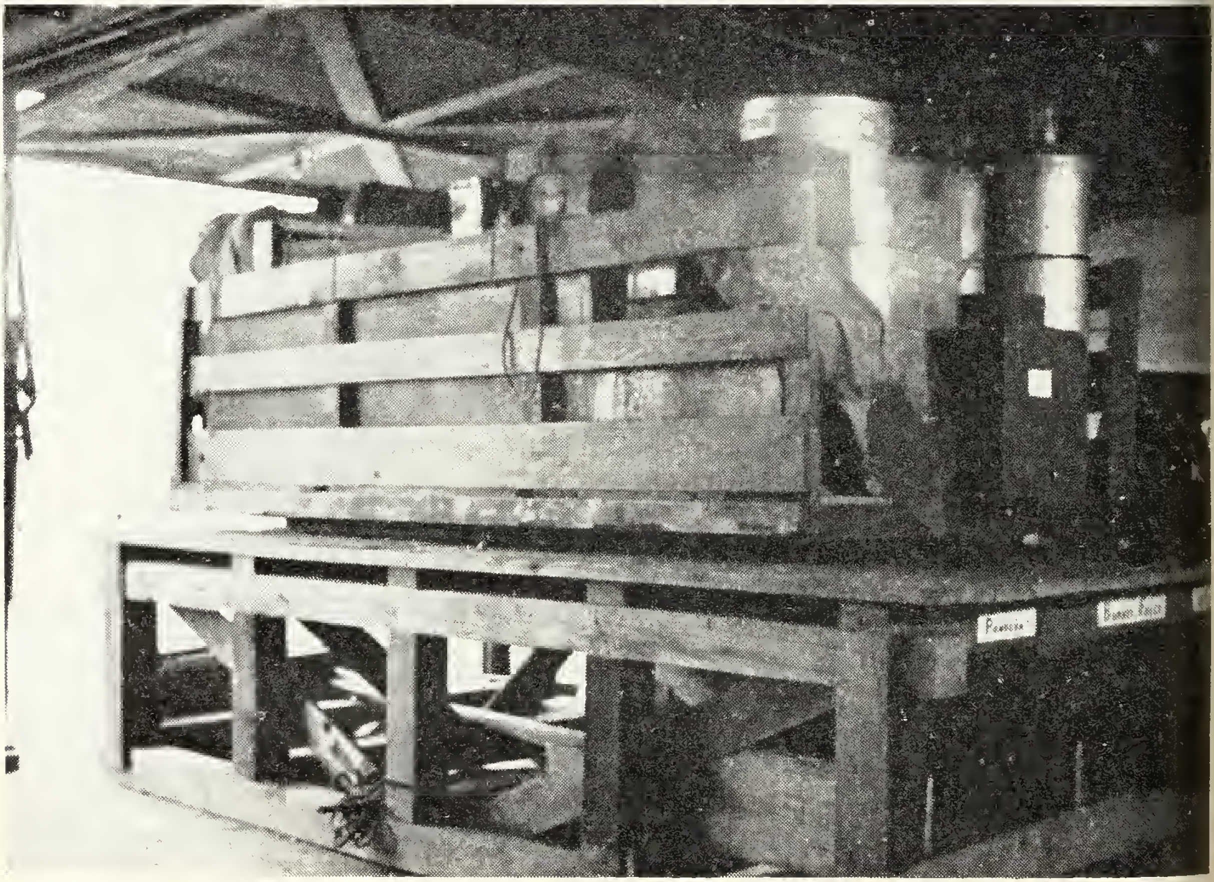
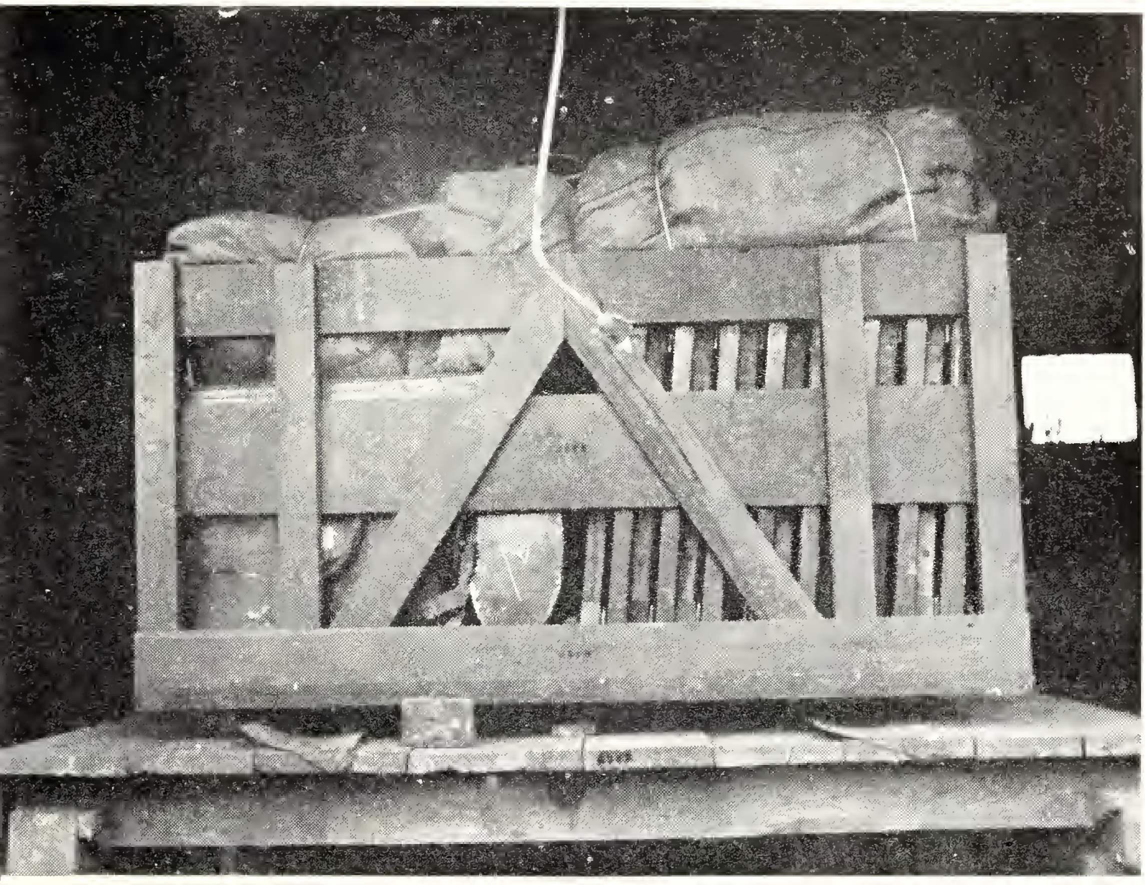


Figure 1.—Transport bed with 50-man fire camp unit on loading platform.

'o facilitate loading, a platform, built of salvage lumber, was ced in a warehouse stall. The 50-man unit fully loaded and ready instant loading onto a truck, is stored on this platform (fig. 1). 'he loading platform is 2 feet longer than the transport bed, and back is 1 inch higher than the front. This slight tilt gives a vnhill roll onto a truck. As another aid in loading, salvage metal ips were placed on the platform deck as wheel channels for the nsport bed (fig. 2).



JRE 2.—Front view of transport bed. Note metal strips on platform deck for wheel channels, and holding wedge.

'he loading platform was constructed to the same height as the of a Ford stakeside used by the district. When a fire strips district headquarters of automotive equipment, a private truck be used to haul the camp unit. Should the private truck bed be her than the loading platform, holes may be dug in the ground the rear wheels to lower the bed to the height necessary for ling.

Vhenever a call for the 50-man unit is received, the district discher has a truck back up to the loading platform in position to l. The dispatcher then pulls out the holding wedges, which pret the unit from rolling off the platform when it is stored, and h a pry bar rolls the unit onto the truck. Chains and binders used to tie the unit to the truck bed.

he time required to load, bind, and start this unit on its way to e is 5 minutes. This is much less than the time formerly required, n each piece of camp equipment and line tools were loaded by d.

Material Carried on the Unit

15 shovels, l. h. r. p.
15 tools, McLeod
15 axes, d. b.
5 tools, Pulaski
3 shears, pruning
1 rake, asphalt
12 files, 8-inch
1 torch, Hauck
48 fusees
50 lamps, electric, head with batteries
40 canteens, 1-gallon
1 set irons, campfire
1 water heater, Flamo
8 tables, folding
1 outfit, mess, 50-man
10 knapsacks
1 funnel, Coleman
50 bags, sleeping or 150 blankets, bed
2 rolls wire, emergency, single or duplex
1 radio, S set
15 signs, campfire
5 gallons kerosene
5 gallons oil, motor, S. A. E. 20
3 brush hooks
1 brush knife
3 saws, felling
3 sledges, 8-pound
6 wedges, steel
12 wedges, wooden
1 pump, barrel
2 flame throwers
5 outfits, back-pack
1 outfit, first aid, large
1 range, Flamo
2 cylinders, Flamo
1 desk, camp boss
4 cans milk, 10-gallon
6 lanterns, gas, Coleman
300 feet rope, ⅜-inch
1 telephone, portable
1 outfit, camp boss
5 gallons gas, white
1 drum gas, leaded, 50-gallon

After the truck with the 50-man unit arrives at a fire camp and the equipment is unloaded, that truck is then available to haul men or tools from the fire camp to the fire line. When the fire camp is disbanded, the 50-man camp equipment is reloaded into the transport bed and returned to the district headquarters where, by use of a set of blocks, the unit is pulled from the truck onto the loading platform.

All equipment is unloaded, checked, and used articles are replaced. In a short while a complete 50-man unit is again ready to roll to a fire.

* * *